

GREEN GIANTS? CHINA'S NATIONAL OIL COMPANIES PREPARE FOR THE ENERGY TRANSITION

**BY DR. ERICA DOWNS
SEPTEMBER 2021**

ABOUT THE CENTER ON GLOBAL ENERGY POLICY

The Center on Global Energy Policy at Columbia University SIPA advances smart, actionable and evidence-based energy and climate solutions through research, education and dialogue. Based at one of the world's top research universities, what sets CGEP apart is our ability to communicate academic research, scholarship and insights in formats and on timescales that are useful to decision makers. We bridge the gap between academic research and policy — complementing and strengthening the world-class research already underway at Columbia University, while providing support, expertise, and policy recommendations to foster stronger, evidence-based policy. Recently, Columbia University President Lee Bollinger announced the creation of a new Climate School — the first in the nation — to tackle the most urgent environmental and public health challenges facing humanity.

Visit us at www.energypolicy.columbia.edu

   @ColumbiaUEnergy

ABOUT THE SCHOOL OF INTERNATIONAL AND PUBLIC AFFAIRS

SIPA's mission is to empower people to serve the global public interest. Our goal is to foster economic growth, sustainable development, social progress, and democratic governance by educating public policy professionals, producing policy-related research, and conveying the results to the world. Based in New York City, with a student body that is 50 percent international and educational partners in cities around the world, SIPA is the most global of public policy schools.

For more information, please visit www.sipa.columbia.edu

For a full list of financial supporters of the Center on Global Energy Policy at Columbia University SIPA, please visit our website at <https://www.energypolicy.columbia.edu/partners>. See below a list of members that are currently in CGEP's Visionary Annual Circle. This list is updated periodically.

Air Products

Anonymous

Jay Bernstein

Breakthrough Energy LLC

Children's Investment Fund Foundation (CIFF)

Occidental Petroleum Corporation

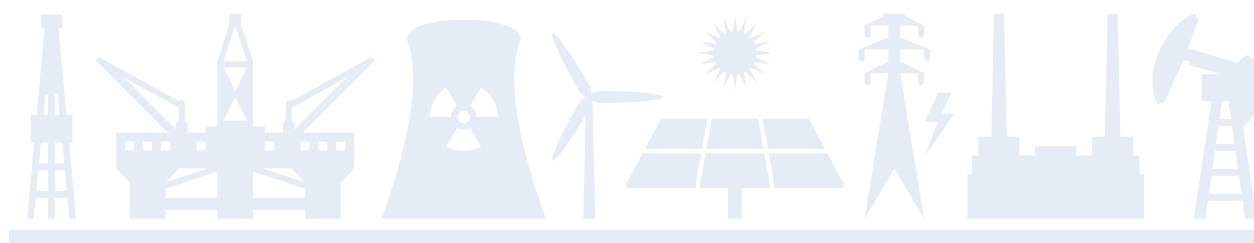
Ray Rothrock

Kimberly and Scott Sheffield

Tellurian Inc.

GREEN GIANTS? CHINA'S NATIONAL OIL COMPANIES PREPARE FOR THE ENERGY TRANSITION

BY DR. ERICA DOWNS
SEPTEMBER 2021



Columbia University CGEP
1255 Amsterdam Ave.
New York, NY 10027
energypolicy.columbia.edu

   @ColumbiaUenergy

ABOUT THE AUTHOR

Dr. Erica Downs is a senior research scholar at the Center on Global Energy Policy. She was formerly a senior research scientist in the China Studies division of the CNA Corporation. Previously she was a senior analyst in the Asia practice at Eurasia Group, a fellow in the John L. Thornton China Center at the Brookings Institution, an energy analyst at the Central Intelligence Agency, and a lecturer at the Foreign Affairs College in Beijing, China.

ACKNOWLEDGMENTS

This report benefitted from exchanges with and comments from Philippe Benoit, Neil Beveridge, Xavier Chen, Ned Downie, Jon Elkind, David Fridley, Julio Friedmann, Marianne Kah, Robert Kleinberg, Joanna Lewis, Arjun Murti, David Sandalow, Deborah Seligsohn, Gavin Thompson, Kevin Tu, Hanling Yang, Yi Wu, and several anonymous reviewers. The author thanks Jiashi Yang for research assistance and Andrea Brody-Barre, Christina Nelson, and Matt Robinson for editorial help.

This paper represents the research and views of the author. It does not necessarily represent the views of the Center on Global Energy Policy. The paper may be subject to further revision.

This work was made possible by support from the Center on Global Energy Policy. More information is available at <https://energypolicy.columbia.edu/about/partners>.



TABLE OF CONTENTS

Executive Summary	05
Introduction	07
China's National Oil Companies	10
Energy Transition Activities of China's NOCs before the 30-60 Targets	15
Managing Greenhouse Gas Emissions	15
Improving Energy Efficiency	16
Increasing Natural Gas Production	17
Investing in Low-Carbon Energy	19
Joining International Climate Bodies	21
Drivers of the Energy Transition Activities of China's NOCs before the 30-60 Targets	24
Concerns about Climate Change	24
Concerns about "Runaway" Energy Demand Growth	26
Concerns about Air Pollution	27
Investor Pressure	30
Foreign Regulatory Requirements	31
International Exposure	32
Why China's NOCs Didn't Do More before the 30-60 Pledges	34
The Oil and Natural Gas Supply Security Imperative	34
The Employment Imperative	35
Financial Pressures	36
What the 30-60 Targets Mean for China's NOCs	38
Oil and Natural Gas Likely to Remain the Core Business	39
A Shift from Oil and Gas Companies to Gas and Oil Companies	41
Expanding beyond Oil and Natural Gas	43
Conclusion	48
Appendix: Sources for Figures and Tables	50
Sources for Figures 1-8	50
Sources for Tables 1-8	53
Notes	57



EXECUTIVE SUMMARY

On September 22, 2020, China's leader, Xi Jinping, made a surprise announcement about China's climate ambitions during remarks to the United Nations General Assembly. He stated that China, the world's largest emitter of greenhouse gases (GHGs), aims to achieve carbon neutrality before 2060. Xi also said that China's GHG emissions would peak before 2030, a slight revision to China's pledge under the Paris Climate Agreement to peak emissions around 2030.

China's new climate targets spurred the country's three major national oil companies (NOCs)—China National Petroleum Corporation (CNPC), China Petrochemical Corporation (Sinopec Group), and China National Offshore Oil Corporation (CNOOC)—to strengthen their climate ambitions. PetroChina (the flagship subsidiary of CNPC), which had already set a goal of achieving near-zero emissions by 2050, intends to peak its carbon emissions by 2025. Sinopec Corp. (the flagship subsidiary of Sinopec Group) also aims to peak its carbon emissions by 2025 and to achieve carbon neutrality by 2050. CNOOC Ltd. (the flagship subsidiary of CNOOC) plans to reduce its GHG emissions by 16 percent between 2020 and 2025 and aims to peak its carbon emissions before 2030 and achieve carbon neutrality before 2060.

This report, part of the China Energy and Climate Program at Columbia University's Center on Global Energy Policy, provides a baseline for understanding how China's NOCs are responding to climate change. It examines the activities the three companies identified as part of their emerging energy transition strategies before Xi unveiled the carbon peaking and carbon neutrality targets, and why they didn't do more. The report then assesses the implications of China's new climate ambitions for its NOCs and lays out their preparations to date for supporting Xi's 2030 and 2060 pledges.

The main findings include the following:

- China's NOCs are balancing support for Beijing's decarbonization agenda with its energy security agenda. Ensuring oil and natural gas supplies for China, which imports more than 70 percent of its crude oil and more than 40 percent of its natural gas, is job number one for the NOCs. However, the companies must also demonstrate that they are developing credible plans to support China's carbon peaking and carbon neutrality goals.
- China's NOCs are shifting from "oil and gas" to "gas and oil" companies. Beijing's new climate targets are reinforcing a shift that was already underway in the companies' domestic production mixes from oil to natural gas. This change is driven by geology (production at China's largest and oldest oil fields is in decline) and policy (Beijing's push to increase natural gas use to improve air quality). China's new climate goals provide its NOCs with another reason to increase natural gas exploration and production. Natural gas can reduce China's GHG emissions if it substitutes for coal and methane emissions are managed.



- China's NOCs are looking beyond oil and natural gas. Although these fossil fuels will remain the NOCs' core business for at least the next decade, the companies recognize that they may have to expand the scope of their operations to adapt to a decarbonizing world. The NOCs are investing in low-carbon energy and technologies where they have comparative advantages:
 - CNOOC Ltd. is capitalizing on its decades of experience with offshore engineering to invest in China's fast-growing offshore wind industry.
 - Sinopec Group seeks to leverage its network of more than 30,000 retail stations to become a leading supplier of hydrogen fuel across China.
 - CNPC's plans are less clear, but the company signaled its intent to increase its participation in the energy transition when it merged its oil and natural gas and new energy divisions in April 2021.

While preparations specific to China's new peaking and neutrality goals are still in the early stages and China's NOCs are unlikely to reinvent themselves anytime soon, the NOCs are aware that they will need to continue to flesh out their plans for a smooth energy transition to show support for China's climate ambitions.



INTRODUCTION

China's leader Xi Jinping unexpectedly announced new climate change goals to the United Nations General Assembly on September 22, 2020.¹ He stated that China, the world's largest emitter of greenhouse gases, aims to achieve carbon neutrality before 2060. Xi also said that China's emissions would peak before 2030, a slight revision to the country's pledge under the Paris Climate Agreement to peak emissions around 2030. These two objectives are often referred to as the "30-60" targets in China.

But even before Xi announced the 30-60 goals, China's three major national oil companies (NOCs)—China National Petroleum Corporation (CNPC), China Petrochemical Corporation (Sinopec Group) and China National Offshore Oil Corporation (CNOOC)—had already begun to sketch out responses to climate change. Some of the activities in the three NOCs' emerging energy transition strategies, such as improving energy efficiency and reducing air pollution, initially had been undertaken to advance two other high priorities of China's leaders: slowing energy demand growth and improving air quality. The NOCs undertook other activities in response to pressure from foreign investors and regulators and exposure to the carbon management practices of multinational corporations. These activities include CNOOC's investment in renewable energy in the 2000s; development of an emissions trading team by CNPC's flagship subsidiary, PetroChina, in 2010; and Sinopec's efforts to improve its climate governance in the 2010s.

The three NOCs had also set greenhouse gas emission reduction targets of varying ambition on the eve of Xi's unveiling of the 30-60 goals. In August 2020, PetroChina, China's largest oil and natural gas producer, announced during its midyear earnings call that it was targeting near-zero emissions by 2050.² In 2019, Sinopec Corp. (a subsidiary of Sinopec Group) and CNOOC Ltd. (a subsidiary of CNOOC), set shorter-term goals. Sinopec Corp. is aiming to reduce its GHG emissions by 12.6 million tons of carbon dioxide (CO₂) equivalent (7.3 percent) between 2018 and 2023.³ CNOOC Ltd. set out to reduce its GHG emissions by 3.2 million tons of CO₂ equivalent between 2015 and 2020.⁴

Xi's announcement of the 30-60 targets has prompted the NOCs to announce additional carbon peaking and carbon neutrality goals. In March 2021, PetroChina and Sinopec Corp. both said they aim to peak their carbon emissions by 2025.⁵ Sinopec Corp. also disclosed that it intends to achieve carbon neutrality by 2050, making it one of a handful of central state-owned enterprises to have a midcentury emissions reduction target as of this writing.⁶

CNOOC Ltd. has set shorter- and longer-term goals to help China meet the 30-60 targets. The company plans to reduce its GHG emissions by 16 percent (1.5 million tons) between 2020 and 2025.⁷ CNOOC Ltd. also aims to peak its carbon emissions before 2030 and achieve carbon neutrality before 2060.⁸ In August 2021, the company's chairman, Wang Dongjin, told reporters, "We have set up a team to study and formulate our plans to implement carbon reduction targets for 2030 and 2060."⁹

China's NOCs have engaged in a flurry of activity to demonstrate support for the 30-60 targets.



All three companies are implementing, to various degrees, many of the same measures that leading international and national oil companies are pursuing to decarbonize their operations and provide their customers with lower-carbon alternatives. Sinopec, already China's largest hydrogen producer, seeks to shift away from producing hydrogen from fossil fuels toward producing hydrogen from renewable energy sources.¹⁰ CNOOC, which has decades of offshore engineering experience, has identified offshore wind as the renewable source of energy that is most compatible with the company's business. CNPC, which plans to increase its investment in renewables and hydrogen, is restructuring its corporate headquarters to reflect the higher priority it attaches to preparing for the energy transition.

That said, securing the oil and natural gas supply of China, the world's largest importer of oil and natural gas, remains job number one for the NOCs. China imported 73 percent of its oil and 43 percent of its natural gas in 2020.¹¹ These numbers probably underpin the importance attached to oil and natural gas supply security in China's 14th Five-Year Plan for the period 2021-2025.¹² Indeed, CNPC, China's largest producer of oil and natural gas, projected in April 2021 that by 2025, China's oil import dependence will range from 70 to 75 percent and its natural gas import dependence will range from 34 to 66 percent.¹³

The elevation of responding to climate change on Xi's policy agenda means that China's NOCs almost certainly will have to balance their efforts to support the 30-60 goals not only with their energy security responsibilities but also with other obligations, such as maintaining large workforces, for at least the next decade. The three NOCs have indicated that this balancing act will initially involve increasing the role of natural gas in their production mixes, which can have energy security, employment, and some climate benefits if natural gas substitutes for coal and methane emissions are controlled. China's NOCs view natural gas as playing an important role in China's energy transition in the 2020s because renewable sources of energy alone cannot meet the country's energy demand during this period. In the meantime, the three NOCs intend to increase investments in renewables and clean energy technologies to demonstrate that they are doing their part to advance the 30-60 goals and to experiment with ways to repurpose existing assets, such as large service station networks and acreage with good solar and wind resources, to adapt to a lower-carbon future.

The energy transition activities of China's NOCs are worth paying attention to for several reasons:

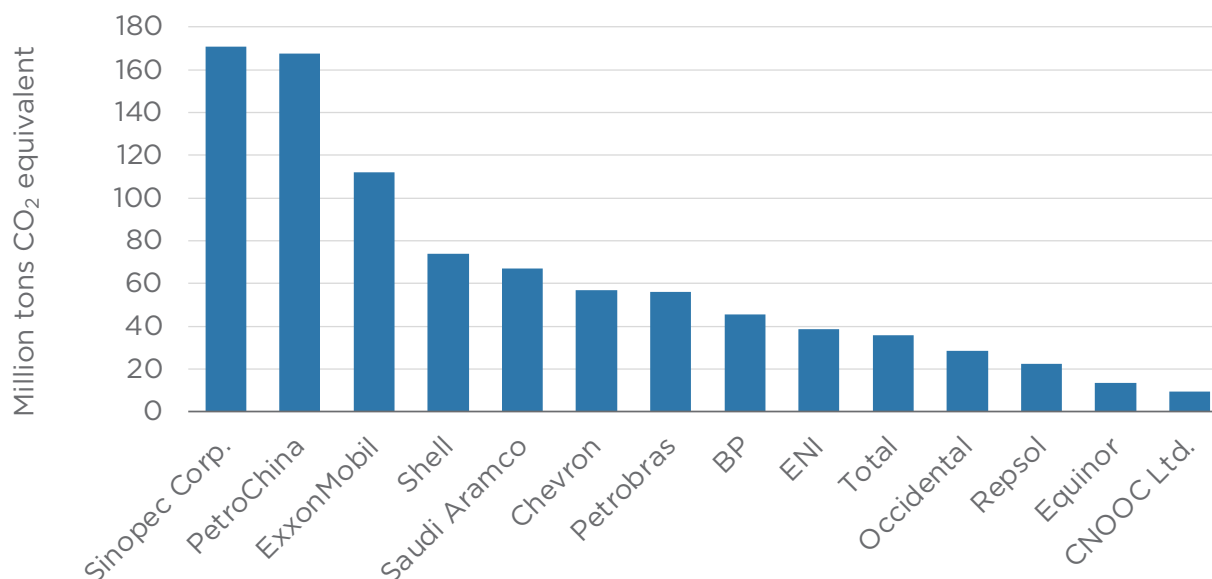
- China's NOCs can help decarbonize the global oil and natural gas industry by decarbonizing their own operations. PetroChina and Sinopec Corp. are two of the largest emitters of greenhouse gasses among publicly traded oil and gas companies (see Figure 1).
- China's NOCs have a role to play in helping China decarbonize. Indeed, Beijing has already called on all companies owned by the central government to actively support the country's carbon peaking and carbon neutrality goals.¹⁴
- A deep dive into the energy transition activities of China's NOCs provides a window into how central state-owned enterprises in one of China's high-emitting industries are responding to the 30-60 goals.



- Climate commitments affect the cost structures of oil companies. Whether and to what extent China's NOCs are making ambitious climate commitments on par with European oil companies has implications for how the companies would fare in head-to-head competition for assets.¹⁵
- The decarbonization agendas of China's NOCs will likely influence their appetites for acquiring additional exploration and production assets overseas and the development of new cross-border pipelines.
- China's NOCs are an avenue for engaging with China on climate change.

This report provides a baseline for understanding how China's NOCs are responding to climate change by offering a comprehensive analysis of what the companies are doing to prepare for the energy transition. Part one introduces China's NOCs. Part two discusses activities the three NOCs had identified as part of their climate agendas before Xi announced the 30-60 goals. Part three explains why China's NOCs engaged in these activities, while part four examines the factors that prevented them from more proactively responding to climate change prior to the announcement of the 30-60 targets. Part five discusses the implications of China's 30-60 goals for the NOCs with a focus on the 2020s.

Figure 1: Combined Scope 1 and Scope 2 emissions of select oil companies in 2020



Note: The data in this figure is from numbers provided by the companies for their GHG emissions from operated assets except for ExxonMobil, which calculates its GHG emissions on a net equity basis, and PetroChina and CNOOC Ltd., which do not indicate whether their GHG emissions are calculated on an operational control or equity share basis. The Scope 2 numbers for Equinor and Shell used in this figure were calculated by the company using the location-based method. Emissions data for Occidental Petroleum is for 2019.

Source: See appendix.



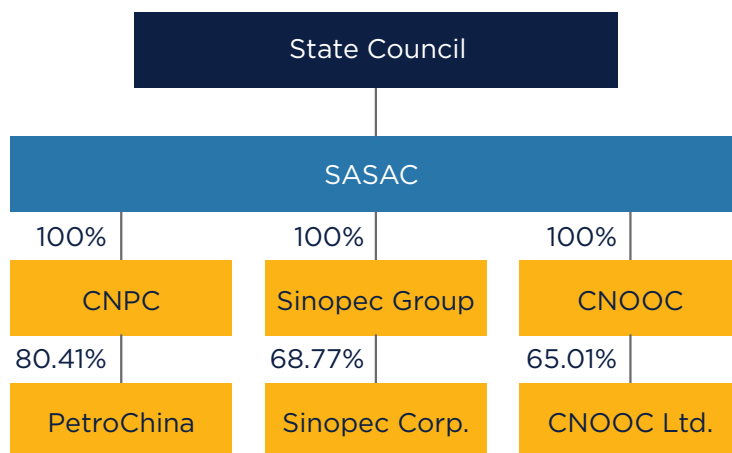
CHINA'S NATIONAL OIL COMPANIES

China's three major national oil companies, CNPC, Sinopec Group, and CNOOC, have flagship subsidiaries: PetroChina, Sinopec Corp., and CNOOC Ltd., respectively. The flagship subsidiaries own most of the upstream and downstream assets of their parent companies. Exceptions include the ownership of certain domestic upstream assets by CNPC, some overseas upstream assets by CNPC and Sinopec Group, and domestic refineries by CNOOC. The flagship subsidiaries also publish more information about their emissions profiles than their parent companies. There are several facts about Beijing's ownership and control of the three NOCs and the companies' operations that are useful to understanding their climate activities.

First, China's NOCs are owned by the Chinese government, and their top executives are appointed by the Communist Party of China, which makes the companies responsive to Beijing's policy priorities to include energy and climate goals. PetroChina, Sinopec Corp. and CNOOC Ltd. are majority owned by their respective parent companies, which are wholly owned by China's central government (see Figure 2).

The parent companies rank among the 97 central state-owned enterprises (SOEs) under the administration of the State-owned Assets Supervision and Administration Commission (SASAC), which reports directly to China's cabinet, the State Council.¹⁶

Figure 2: Ownership of China's NOCs



Note: This diagram reflects PetroChina's ownership on December 31, 2020; Sinopec Corp.'s ownership on April 15, 2021; and CNOOC Ltd.'s ownership as of March 31, 2021.

Source: See appendix.



CNPC, Sinopec Group, and CNOOC belong to the group of 50 “core” central SOEs regarded as important to China’s economic development and national security.¹⁷ The top executives of the NOCs and other “core” central SOEs generally hold vice-ministerial rank and are appointed, removed, and promoted by the Central Organization Department (COD) of the Communist Party of China (CPC).¹⁸ The COD is the human resources arm. It oversees the appointment of leadership positions throughout China, including at government ministries, SOEs, universities, think tanks, and media outlets.¹⁹ Consequently, the extent to which the heads of China’s NOCs advance the economic and political interests of the party plays a role in determining their career prospects.

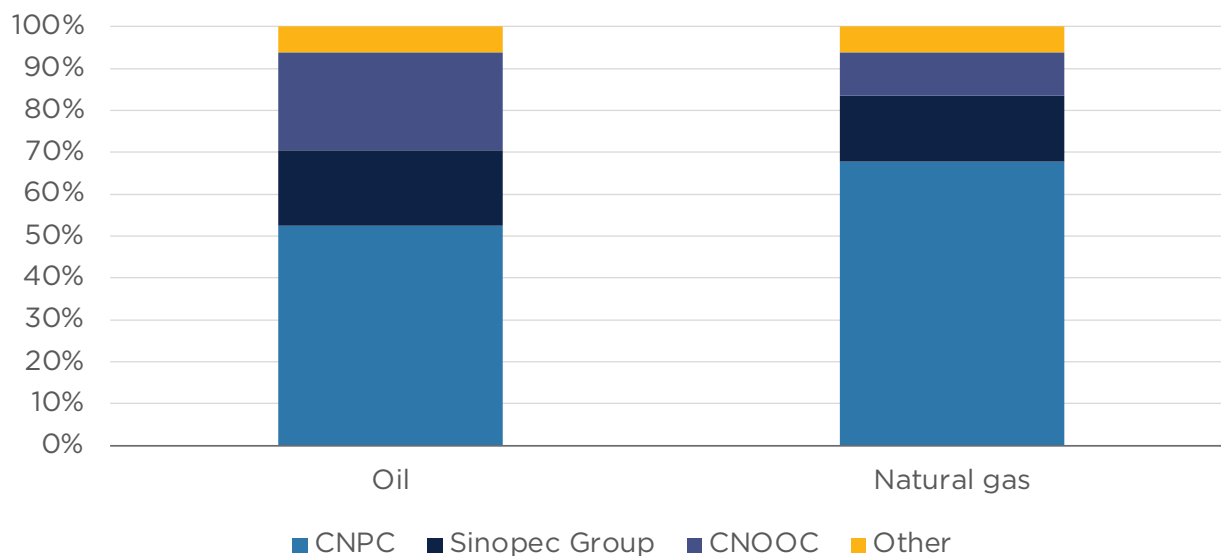
The authority of the COD to appoint top executives extends, indirectly, to PetroChina, Sinopec Corp., and CNOOC Ltd. The individuals selected as chairmen and general managers of the parent companies often serve as the chairmen of the board of their flagship subsidiaries. For example, the current chairmen of CNPC and CNOOC are also the chairmen of PetroChina and CNOOC Ltd., respectively.²⁰ Zhang Yuzhuo also concurrently served as chairman of Sinopec Group and Sinopec Corp. prior to his promotion to party secretary of the China Association of Science and Technology, an organization that serves as a bridge between the CPC and China’s science and technology community, in August 2021.²¹

Second, PetroChina, Sinopec Corp., and CNOOC Ltd. are publicly traded companies listed on stock exchanges, including those in Shanghai, Hong Kong, and New York, which provide actors other than China’s party-state with an avenue to influence the NOCs’ responses to climate change.²² The NOCs engage with their shareholder or shareholder representatives, including institutional investors, on climate change. For example, EOS at Federated Hermes has engaged with PetroChina and Sinopec Corp. to help ensure their corporate strategies are aligned with the Paris Agreement goal of limiting climate change to well below 2°C, and ideally to 1.5°C, an issue that will be discussed later in this report.²³

Third, China’s NOCs dominate the Chinese oil industry, which makes them key actors in China’s efforts to achieve carbon neutrality by 2060. CNPC, Sinopec Group, and CNOOC accounted for more than 90 percent of China’s oil production of 3.9 million barrels per day (bpd) and more than 90 percent of its natural gas production of 192.5 billion cubic meters (bcm) in 2020 (see Figure 3). In addition, the three NOCs operate about 60 percent of China’s refining capacity (see Figure 4).²⁴

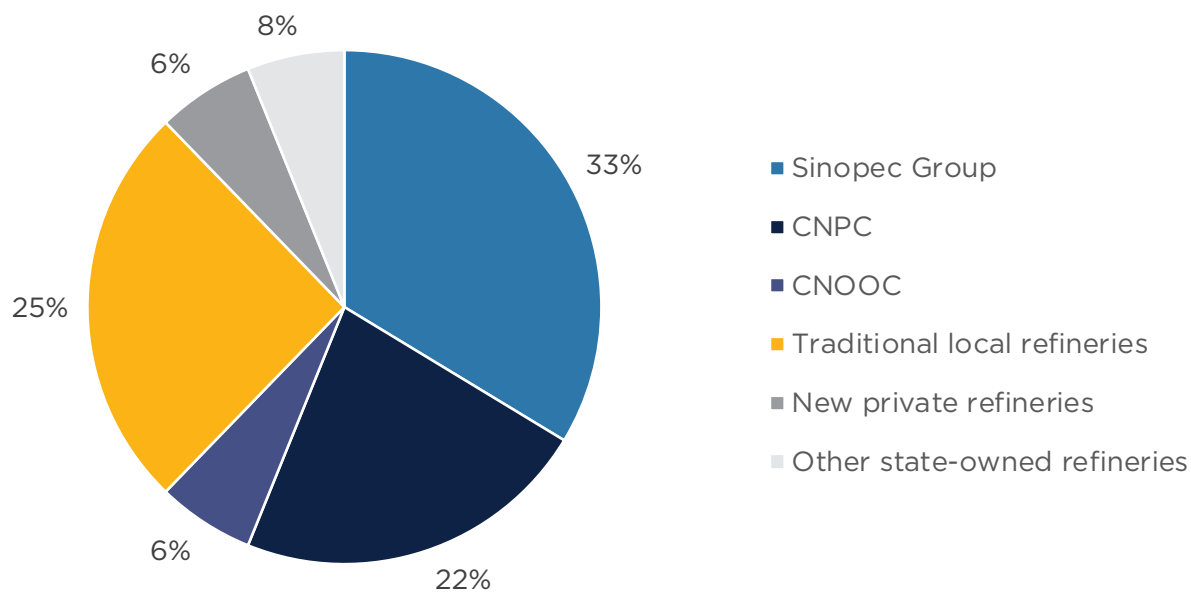


Figure 3: China's oil and natural gas production in 2020



Source: See appendix.

Figure 4: China's refining capacity in 2019

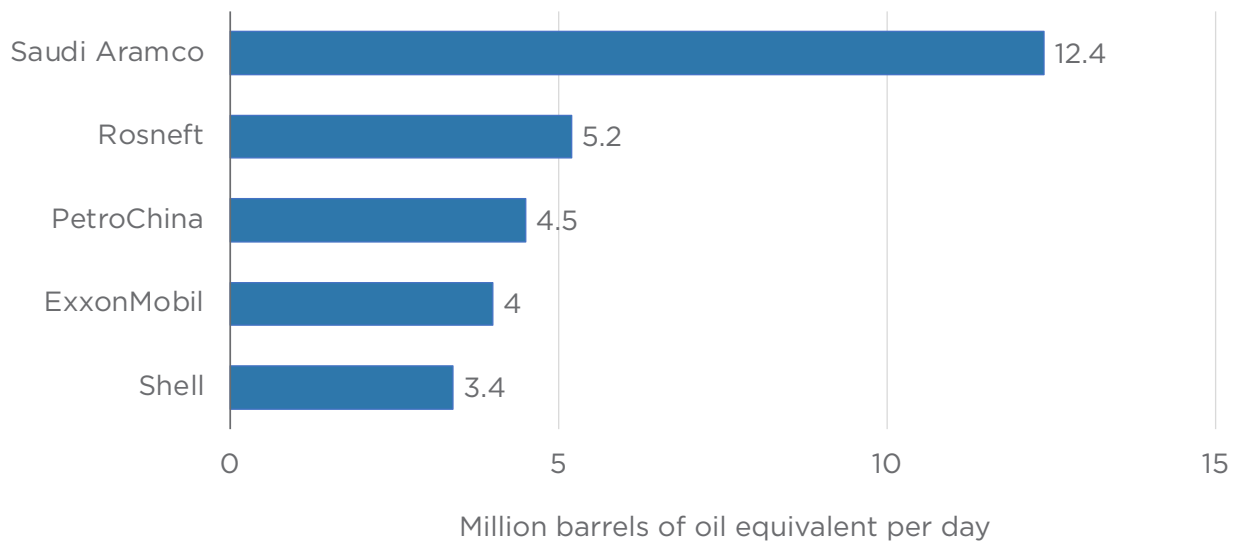


Source: See appendix.



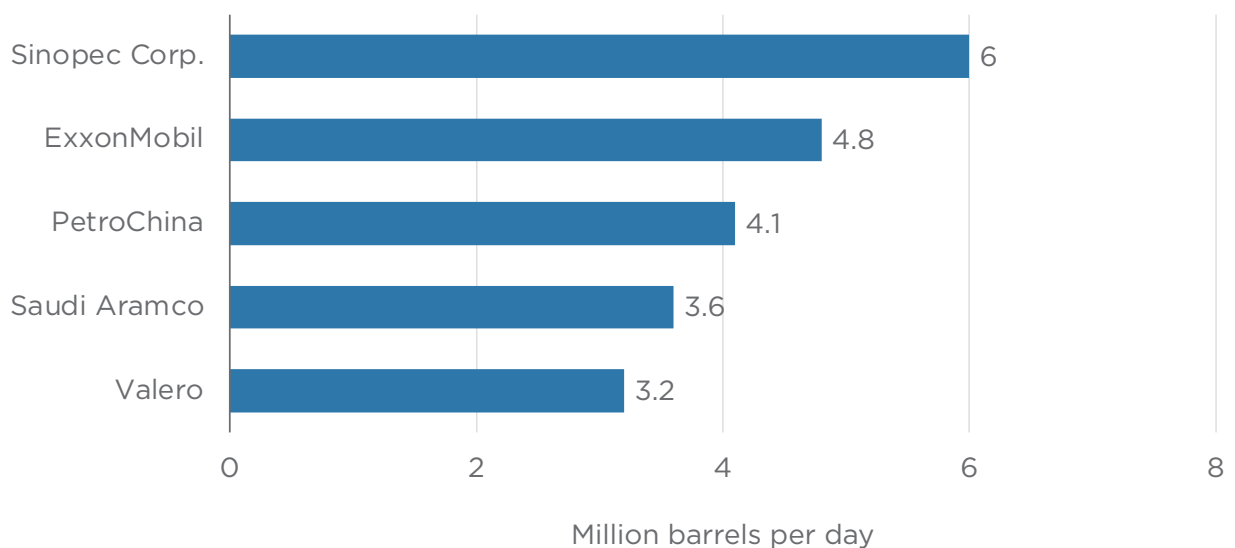
Fourth, PetroChina and Sinopec are major players in the world's oil and natural gas industry, which gives them a role to play in its decarbonization. PetroChina is the world's third-largest publicly traded oil and gas producer and its third-largest publicly traded refining company by capacity (see Figures 5 and 6). Sinopec is the world's largest refiner by capacity.

Figure 5: World's largest publicly traded oil and gas producers in 2020



Source: See appendix.

Figure 6: World's largest publicly traded refining companies by capacity in 2020



Source: See appendix.



Fifth, China's NOCs operate assets around the world, which subjects them to foreign regulatory requirements including those of Canada, the European Union, the United Kingdom and the United States. CNPC is China's largest overseas oil and natural gas producer (see Table 1). In 2020, the company produced 1.6 million bpd of oil and 29.8 bcm of natural gas abroad, including PetroChina's overseas output of 465,000 bpd of oil and 4.4 bcm of natural gas.

Table 1: Overseas oil and natural gas production of China's NOCs in 2020

Company	Oil production (bpd)	Gas production (bcm)
CNPC	1,591,715	29.75
<i>of which: PetroChina</i>	464,657	6.4
Sinopec	678,660	10.2
<i>of which: Sinopec Corp.</i>	95,315	0
CNOOC	640,019	10.5
<i>of which: CNOOC Ltd.</i>	341,560	4.4

Source: See appendix.



ENERGY TRANSITION ACTIVITIES OF CHINA'S NOCS BEFORE THE 30-60 TARGETS

China's NOCs had already begun to identify elements of their responses to climate change before Xi announced China's ambition to achieve carbon neutrality before 2060. Their energy transition activities are similar to those undertaken by two other leading national oil companies, Equinor and Saudi Aramco (more on their efforts in a text box toward the end of this section). The three NOCs' climate actions are discussed thematically below with differences between the companies highlighted.

Managing Greenhouse Gas Emissions

China's NOCs publicly report greenhouse gas (GHG) emissions. CNOOC Ltd. began reporting its Scope 1 and Scope 2 emissions in 2016, followed by Sinopec in 2017 and PetroChina in 2019 (see Table 2). PetroChina began disclosing this information later than its domestic peers in part due to the large number of assets to be metered and the large number of employees to be trained in gathering and reporting data.²⁵ Indeed, PetroChina stated in 2018 that it had been working on improving its system for GHG emission accounting and reporting and collecting data from all of its units.²⁶

Table 2: Greenhouse gas emissions of China's NOCs

		Million tons of CO ₂ equivalent				
		2016	2017	2018	2019	2020
CNOOC Ltd.	Scope 1	6.735	7.736	7.345	8.597	9.123
	Scope 2	0.36	0.093	0.135	0.186	0.222
	Scope 1+2	7.095	7.829	7.48	8.783	9.345
PetroChina	Scope 1				132.17	127.57
	Scope 2				41.91	39.87
	Scope 1+2				174.08	167.44
Sinopec Corp.	Scope 1		123.05	128.57	125.68	128.58
	Scope 2		39.61	42.95	45.01	42.36
	Scope 1+2		162.66	171.52	170.69	170.94

Source: See appendix.



Categorizing Greenhouse Gas Emissions

GHG Protocol, which provides the world's most widely accepted GHG accounting standards, categorizes a company's GHG emissions into three "scopes":²⁷

Scope 1 emissions are direct GHG emissions from sources owned or controlled by a company, such as emissions from a refinery or an oil truck.

Scope 2 emissions are indirect GHG emissions from the generation of energy purchased by a company, such as electricity bought to power its operations.

Scope 3 emissions are all other indirect emissions that result from a company's value chain, such as the combustion of diesel or gasoline by a consumer.

As noted in the introduction, PetroChina and Sinopec Corp. rank among the highest GHG emitters on a gross basis when compared to other leading publicly traded oil companies. The two companies' high GHG emissions are partly due to their large upstream and downstream operations.²⁸ In 2020, 84 percent of Sinopec Corp.'s emissions came from refining and chemicals.²⁹ (PetroChina does not provide a similar breakdown of GHG emissions by business line.) In contrast, CNOOC Ltd. ranks among the world's lowest emitters in terms of both emissions per barrel of oil equivalent produced and gross emissions, in part because it does not operate any refineries.³⁰

China's NOCs do not report scope 3 emissions, which occur during the combustion of their oil and natural gas products by end users. Scope 3 emissions account for the majority of the GHG emissions associated with the oil and natural gas industry. For example, Shell reported in 2017 that scope 3 emissions accounted for 77 percent of its total emissions.³¹

As noted in the introduction, the three NOCs had set emissions reduction targets before Xi announced the 30-60 goals. PetroChina's objective of achieving near-zero emissions by 2050 is probably the most ambitious. Meanwhile, Sinopec Corp. aims to reduce its GHG emissions by 12.6 million tons of CO₂ equivalent between 2018 and 2023. CNOOC Ltd. set out to reduce its GHG emissions by 3.2 million tons of CO₂ equivalent between 2015 and 2020.

Improving Energy Efficiency

China's NOCs identify improving energy efficiency as a component of their climate strategies. However, the data on energy conservation released by China's NOCs suggests that China's mature oil fields are complicating their efforts to improve energy efficiency; the amount of energy the companies consumed for every unit of oil equivalent produced has increased or remained relatively flat in recent years.

PetroChina and CNOOC Ltd. have published data on energy consumption per unit of oil and natural gas produced since 2015 and 2016, respectively (see Table 3). The amount of energy CNOOC Ltd. has used per each ton of oil and natural gas increased by 17 percent from 2016 to 2019. In contrast, PetroChina's energy consumption per unit of oil and natural gas produced



fell by 7 percent from 2015 to 2016 and then remained relatively flat through 2020.

Table 3: Energy efficiency data for CNOOC Ltd. And PetroChina (kilograms of standard coal consumption per ton of oil and natural gas production)

	2015	2016	2017	2018	2019	2020
CNOOC Ltd.	NA	47	49	52	55	55
PetroChina	128	119	118	122	119	118

Source: See appendix.

Sinopec Corp. has published data on its energy consumption per RMB 10,000 (\$1,500) of production value since 2017 (see Table 4). However, these numbers do not provide any insight into whether the company used energy more efficiently in 2018 than it did in 2017. Sinopec Corp. reported the same economic energy intensity in 2017 and 2018 (0.496 tons of standard coal consumed per RMB 10,000 of production value) but did not release any information about whether this was the result of the value of its products (which include oil, natural gas, refined products, and petrochemicals) increasing to the same degree that its energy use increased or the result of the value of its products decreasing to the degree that its energy use decreased.³²

Table 4: Sinopec's energy efficiency data

Indicator	Unit	2017	2018	2019	2020
Energy consumption per RMB 10,000 of production value	Tons of standard coal	0.496	0.496	0.494	0.490

Source: See appendix.

Increasing Natural Gas Production

China's NOCs describe increasing natural gas production as a key element of their decarbonization strategies. During PetroChina's midyear earnings conference call in August 2020, the company's chief financial officer, Chai Shouping, stated that natural gas will have an "irreplaceable position" in PetroChina's energy transition.³³ That same month, during CNOOC Ltd.'s midyear earnings conference call, the company's chairman, Wang Dongjin, said that CNOOC Ltd. would increase the share of natural gas in its production mix as part of its green and low-carbon development strategy.³⁴ Two years earlier, Sinopec Corp.'s spokesman, Lü Dapeng, told China's media in 2018 that the company regards the "transition to natural gas" as one of the largest components of its move toward a lower-carbon energy mix.³⁵

The importance these NOC executives attach to natural gas as a transition fuel is reflected in



their companies' production targets for 2025. All three companies plan to expand the share of natural gas in their production mixes. PetroChina and Sinopec Corp. have also set targets for increasing production of unconventional gas (see Table 5).

Table 5: Natural gas production targets of China's NOCs for 2025

Company	Natural gas production targets for 2025
CNOOC Ltd.	<ul style="list-style-type: none"> • Increase the share of natural gas in its production mix to 30% from approximately 20% in mid-2020
PetroChina	<ul style="list-style-type: none"> • Increase the share of natural gas in its domestic production mix to 55% from 45% in 2019 • Increase shale gas production to 20 bcm from 6 bcm in 2019 20% in mid-2020 • Increase tight gas production to 35 bcm from 28.6 bcm in 2019 20% in mid-2020
Sinopec Corp.	<ul style="list-style-type: none"> • Increase the share of natural gas in its production mix to 50% in 2023 from 41% in 2019 • Increase natural gas production to 46 bcm from 29.67 bcm in 2019 • Increase shale gas production to 13 bcm from 7.34 bcm in 2019

Source: See appendix.

To be sure, increased natural gas production has a role to play in reducing China's greenhouse gas emissions if methane emissions are controlled. Studies show that coal-to-gas switching in China, where coal accounted for 57 percent of China's energy consumption in 2021, can lower China's greenhouse gas emissions.³⁶ According to the International Energy Agency, coal-to-gas switching reduces CO₂ emissions by 33 percent when providing heat and 50 percent when producing electricity.³⁷

However, the climate change benefits of substituting natural gas for coal during the energy transition could be reduced or eliminated if there are leaks of methane during the production, distribution, or consumption of natural gas. This is because methane is a much more potent gas than carbon dioxide; a methane molecule is roughly 90 times more effective at trapping heat than a molecule of carbon dioxide over a 20-year period.³⁸ Specifically, the climate benefits of replacing coal with natural gas are negated if the total amount of methane leaked in the supply chain is more than a few percent of the natural gas consumed.³⁹

China's NOCs are doing many of the same things that international oil companies are doing to prevent methane emissions,⁴⁰ including emission accounting (all three companies),⁴¹ methane recovery (all three companies),⁴² avoidance of routine flaring (CNPC, PetroChina, and Sinopec Corp.)⁴³ and implementation of leak detection and repair programs (CNPC only).⁴⁴

CNPC reduced its methane intensity in 2019 by 12.3 percent below the 2017 level and, in July 2020, announced a new aim to halve its intensity by 2025.⁴⁵ The company does not disclose its methane emissions. Sinopec Corp. has set a methane reduction target but has not disclosed it.⁴⁶



Investing in Low-Carbon Energy

China's NOCs were cautiously making investments in low-carbon energy and technology before Xi set the 30-60 goals. The companies are most active in areas where they have comparative advantages. CNOOC is focusing on offshore wind, while Sinopec Group has ambitious plans for building hydrogen refueling stations. CNPC leads its domestic peers in the deployment of carbon capture, utilization, and storage (CCUS).

CNOOC: Investing in Offshore Wind

CNOOC is investing in China's fast-growing offshore wind industry because of its long history of developing and operating offshore oil and natural gas projects.⁴⁷ (CNOOC began operating in offshore China in 1982.) This track record allows the company to overcome the biggest challenge that onshore wind developers face in moving offshore: a lack of experience in offshore engineering.⁴⁸ Indeed, CNOOC pioneered the development of China's offshore wind sector in 2007 when it began operating China's first wind power plant in the Bohai Sea to supply electricity to one of its offshore oil fields.⁴⁹

CNOOC returned to the offshore wind sector in January 2019 when CNOOC Ltd. invested in an offshore wind project in Jiangsu province with a capacity of 300 megawatts (MW), which connected to the power grid in September 2020.⁵⁰ CNOOC Ltd. established CNOOC Renewable Energy Co., which is dedicated to the offshore wind business, in 2019.⁵¹ The company's CEO, Xu Keqiang, told reporters in January 2020 that CNOOC Ltd. will increase the ratio of offshore wind power in its portfolio to prepare for the energy transition. He also said that the company is focusing on projects in Guangdong, Jiangsu, and Fujian provinces and plans to spend 3–5 percent of its annual budget on offshore wind.⁵² In April 2020, CNOOC Ltd. won a development license for its second offshore wind project in Shantou, Guangdong province, which has an expected capacity of 1,000 MW.⁵³

Sinopec Group: Hydrogen Giant

Sinopec Group seeks to leverage its roles as China's largest refiner and operator of the country's largest network of retail stations to become a leading supplier of hydrogen fuel across China. The company is already China's biggest producer of hydrogen, which it uses for refining and petrochemical production.⁵⁴ Sinopec Group's hydrogen output is 3.5 million tons per year, 14 percent of the national total, but its output is mainly gray hydrogen (meaning it burns fossil fuels in its production; see the text box).⁵⁵ Sinopec Group also operates more than 30,000 retail stations nationwide.⁵⁶



Three Colors of Hydrogen

Most—if not all—of the hydrogen Sinopec Group produces is “grey hydrogen” made from fossil fuels in a process that generates CO₂ as a byproduct.⁵⁷ In order for hydrogen to help Sinopec Group decarbonize its operations and provide its customers with low- or zero-carbon fuels, the company will need to replace its grey hydrogen with blue or green hydrogen. Blue hydrogen is also made from fossil fuels but with carbon capture and storage, and green hydrogen is made from renewables. Ninety-six percent of the hydrogen produced today is made from fossil fuels.⁵⁸ Green and blue hydrogen are not yet cost competitive with grey hydrogen. According to the hydrogen strategy published by the European Union in July 2020, grey hydrogen costs \$1.80 per kilogram (kg), blue hydrogen costs \$2.40 per kg and green hydrogen costs between \$3 and \$6.55 per kilogram.⁵⁹

Sinopec Group’s expansion in China’s hydrogen sector is part of the company’s aspiration to become a world-leading clean energy and chemical corporation.⁶⁰ At an internal study session on the company’s hydrogen development strategy on July 21, 2020, the company’s then chairman, Zhang Yuzhuo, said that as technology matures and costs drop significantly, hydrogen energy is ushering in a period of strategic opportunity for rapid development. He also stated that Sinopec Group would continue to invest in hydrogen, aiming to form a “certain scale” of high-purity hydrogen production capacity during the 14th Five-Year Plan period (2021–2025).⁶¹

Sinopec Corp. had begun to build hydrogen refueling stations at its existing retail sites before Xi unveiled the 2060 carbon neutrality target. In July 2019, the company opened the first service station in China that combines hydrogen fueling and the retail sale of diesel and gasoline in the city of Foshan in Guangdong province.⁶² By the end of 2020, Sinopec Corp. had developed 27 of the roughly 100 hydrogen refueling stations in China.⁶³ Sinopec Corp. has also agreed to supply hydrogen to fuel cell vehicles in Beijing and Zhangjiakou to support the sustainability agenda of the 2022 Winter Olympics, which the two cities are cohosting.⁶⁴

PetroChina and CNOOC are also exploring hydrogen. In April 2020, PetroChina agreed to build hydrogen refueling stations in Beijing in collaboration with a subsidiary of carmaker Beijing Automotive Industry Holding Co., Ltd. and a new energy technology developer, Beijing SinoHytec Co., Ltd.⁶⁵ In July 2020, CNOOC’s subsidiary, CNOOC Energy and Technology Services, and Linde, a global leader in hydrogen technology, signed a memorandum of understanding to jointly develop China’s hydrogen energy industry.⁶⁶

CNPC: Capturing Carbon

CNPC leads China’s NOCs in the deployment of carbon capture, utilization and storage technology. In 2018, the company’s CCUS for an enhanced oil recovery (EOR) project at the Jilin oil field in northeastern China began commercial operations, making it the world’s 18th large-scale CCUS project.⁶⁷ It has a capacity of 600,000 tons per annum of CO₂.⁶⁸ (For comparison, according to the Global CCS Institute, of the 28 commercial carbon capture and storage facilities in operation globally in 2020, the smallest has a capacity of 100,000 tons



per annum and the largest has a capacity of 700,000 tons per annum.⁶⁹) CNPC injected more than 1.5 million tons of CO₂ into the Jilin oil field during the 11 years it operated the Jilin CCUS-EOR project as a demonstration project (2007–2018).⁷⁰

CNPC's leading position is due to both geography and history. In terms of geography, the location of the Jilin oil field close to a low-cost source of CO₂ has enabled it to circumvent the high capture and transportation costs that hinder the development of other CCUS-EOR projects in China.⁷¹ The CO₂ for the Jilin CCUS-EOR project is captured during the processing of natural gas extracted from the Changling field. The gas is 22.5 percent CO₂ and would otherwise be vented.⁷² The CO₂ is then transported about 50 kilometers by pipeline for injection into the Jilin oil field.⁷³

In terms of history, CNPC has decades of experience experimenting with different types of EOR, including CCUS-EOR at its famed Daqing oil field, the discovery of which in 1959 enabled China to become self-sufficient in oil in the mid-1960s and a major oil exporter within East Asia in the 1980s before the country shifted back to a net oil importer in 1993. CNPC's efforts to squeeze more and more oil out of Daqing made the field a hotbed of EOR activity, where “nearly every sort of enhanced recovery method has been tried.”⁷⁴

CNPC is also capturing carbon from hydrogen production from one of its refineries in Xinjiang for enhanced oil recovery as part of its participation in the CCUS KickStarter initiative of the Oil and Gas Climate Initiative (OGCI; more on the OGCI below).⁷⁵ The initiative aims to decarbonize five commercial hubs to facilitate large-scale commercial investment in CCUS. The other four hubs are in the Netherlands, Norway, the United Kingdom, and the United States.⁷⁶

CNPC is not the only NOC involved in CCUS for EOR. Sinopec is also developing a large-scale CCUS-EOR project. The Sinopec Qilu Petrochemical Project began construction in 2018.⁷⁷ It will capture CO₂ from chemical production for injection into the Shengli oil field, 75 kilometers away.⁷⁸ The project's capacity is listed as 0.35–0.5 million tons per year.⁷⁹ It is expected to come online in 2020–2021.⁸⁰

Joining International Climate Bodies

CNPC joined the Oil and Gas Climate Initiative in 2015.⁸¹ The OGCI is an organization established in 2014 by the CEOs of major international and national oil and natural gas companies to accelerate the industry's response to climate change through their own actions and by setting an example for other oil and natural gas companies to follow.⁸² The OGCI's members are BP, Chevron, CNPC, Eni, Equinor, ExxonMobil, Occidental, Pemex (inactive), Petrobras, Repsol, Saudi Aramco, Shell, and Total.⁸³ They accounted for more than 30 percent of the world's oil and natural gas production and almost 20 percent of the world's primary energy consumption in 2018.⁸⁴

The OGCI has set short-term methane intensity and carbon dioxide intensity reduction targets. In September 2018, the OGCI announced a target to lower by 2025 the collective average methane intensity of the aggregated upstream operations of its member companies by one-fifth (below 0.25 percent) with the aim to achieve one-third (0.20 percent) from a baseline of 0.32 percent in 2018.⁸⁵ In July 2020, the OGCI announced a target to reduce the collective average carbon dioxide emissions intensity of member companies' upstream



operations by 9–13 percent between 2017 and 2025 (from a collective baseline of 23 kilograms of carbon dioxide per barrel of oil equivalent in 2017 to between 20 and 21 kilograms of carbon dioxide per barrel of oil equivalent by 2025).⁸⁶

In addition to contributing to the OGCI's methane and carbon dioxide emissions targets, OGCI member companies agree to⁸⁷

- Support the goals of the Paris Agreement;
- Commit to the CEO's personal involvement in the OGCI Steering Committee;
- Report key data using common methodologies to measure progress in key areas;
- Support the OGCI's methane intensity target;
- Support the OGCI's CCUS aspiration;
- Make senior staff and experts available for OGCI activities;
- Share information on low carbon best practices and experience;
- Support the initiative Zero Routine Flaring by 2030; and
- Contribute \$100 million over 10 years to OGCI Climate Investments, a fund that supports the development of technologies that lower emissions (or in the case of CNPC, contribute \$100 million to an investment fund created by CNPC and OGCI Climate Investments with a focus on emissions reduction technologies in China).⁸⁸

Responses to the OGCI have been mixed. Some observers have criticized the OGCI's methane and carbon dioxide targets as unambitious because they seek to reduce the intensity of emissions (which allows for an increase in emissions overall) instead of absolute emissions and do not cover scope 3 emissions.⁸⁹ Critics also note that the \$100 million contributed to OGCI Climate Investments is just a tiny fraction of the companies' overall capital expenditure and criticize the OGCI for a lack of data transparency.⁹⁰ Other observers argue that having some greenhouse gas reduction targets is better than having none. Still others applaud the OGCI for including CEOs from national oil companies because it demonstrates that climate change is an issue on which both international and national oil companies must engage.⁹¹

Responses to Climate Change by Other Leading NOCs: Snapshots of Equinor and Saudi Aramco

Equinor, Norway's NOC, and Saudi Aramco, Saudi Arabia's NOC, illustrate the variation in the climate mitigation strategies of leading NOCs. Both companies rank among the world's lowest-emission producers. Equinor, which sees global oil demand peaking by around 2027–2028, seeks to transform itself from an oil company to an energy company by increasing investment in renewables.⁹² In contrast, Saudi Aramco maintains that oil demand will be healthy in the long term, peaking in the late 2030s,



and that the company is well positioned to meet demand because of its low-cost and low-emission crude production.⁹³

Equinor

Equinor is committed to being a leader in the energy transition, according to the company's CEO, Anders Opedal. On his first day on the job, November 2, 2020, he announced that Equinor has the ambition to achieve net-zero emissions by 2050. The company's pledge covers not only Scope 1 and Scope 2 emissions but also Scope 3 emissions.⁹⁴ Equinor has also set interim goals. For example, it intends to reduce the carbon intensity of its globally operated oil and natural gas production from 9.5 in 2019 to less than 8 kilograms of CO₂ per barrel of oil equivalent in 2025.⁹⁵ The company's upstream operated carbon intensity improved to 8.0 kilograms (kg) per barrel of oil equivalent (boe) in 2020, well below the global industry average of 17 kg per boe.⁹⁶ Equinor also aims to achieve carbon neutral global emissions by 2030.⁹⁷

Equinor seeks to meet its climate ambitions in several ways.⁹⁸ First, the company will continue to invest in renewables with the aim of increasing its production capacity to 4–6 gigawatts (GW) by 2026 and 12–16 GW by 2035. The company's initial focus is on wind power because of its experience operating offshore, which includes five decades of ocean engineering and project management expertise.⁹⁹ Second, Equinor is investing in the development of carbon capture and storage and hydrogen technologies. Third, the company will produce less oil and natural gas in the longer term even though it expects its output to increase by 3 percent per year from 2019 to 2026.

Saudi Aramco

Saudi Aramco aims to maintain its position as one of the world's lowest-cost and lowest-emission oil producers to deliver the supplies the company expects the world to need for decades.¹⁰⁰ The company extracts crude at just \$2.80 a barrel, which is reportedly less than half of Equinor's lifting cost and one-fifth that of ExxonMobil's.¹⁰¹ The carbon intensity of Saudi Aramco's oil and natural gas production in 2020 was 10.5 kilograms of CO₂ per barrel of oil equivalent.¹⁰²

Saudi Aramco attributes the relatively low-carbon intensity of its operations to the unique geology of Saudi Arabia's reserves and the company's innovation and reservoir management practices.¹⁰³

Saudi Aramco is working to find ways to reduce its carbon emissions. For example, the company is working to develop more efficient internal combustion engines and new fuel formulations.¹⁰⁴ The company is also investing in the development of blue hydrogen. According to Aramco's chief technology officer, Ahmad Al-Khowaiter, the company is "going to have a large share" of the global market for blue hydrogen, which the company does not expect to be fully developed before 2030.¹⁰⁵ In September 2020, Aramco exported the world's first shipment of ammonia made from blue hydrogen to Japan for use in power generation.¹⁰⁶



DRIVERS OF THE ENERGY TRANSITION ACTIVITIES OF CHINA'S NOCS BEFORE THE 30-60 TARGETS

Before Xi announced the 30-60 targets, China's NOCs pursued the activities on their emerging energy transition agendas for multiple reasons in addition to furthering Beijing's climate change objectives. To be sure, during the 12th Five-Year Plan period (2011-2015), the Chinese government encouraged China's NOCs to increase natural gas production to generate fewer greenhouse gas emissions and began to require China's NOCs to measure and manage greenhouse gas emissions. However, in the two decades before Xi unveiled the 30-60 targets, Beijing's campaigns to slow energy demand growth and reduce air pollution were much more powerful drivers of the NOCs' efforts to use energy more efficiently and increase natural gas production, both of which had the added benefit of slowing the growth of GHG emissions. Meanwhile, pressure from foreign investors and regulators and exposure to the carbon management practices of multinational corporations also influenced the nascent energy transition activities of China's NOCs.

Concerns about Climate Change

The Chinese government had already started to interact with China's NOCs on climate change about a decade before Xi unveiled the 30-60 targets. Beijing began to encourage China's NOCs to increase natural gas production to lessen GHG emissions before it launched its campaign against air pollution in 2013. In addition, China's government mandated that firms in certain industries, including oil and natural gas, report greenhouse gas emissions and included the NOCs in pilot emission trading schemes (ETSs).

Increasing Natural Gas Production

China's 12th and 13th Five-Year Plans for the Development of Natural Gas (for the periods 2011-2015 and 2016-2020, respectively) focus on developing the natural gas supplies and infrastructure needed to increase natural gas use and identify responding to climate change as a reason to do so. The 12th Five-Year Plan for natural gas, released on October 22, 2012, states that if China's natural gas consumption reaches 230 billion cubic meters (bcm) by 2015, an increase of about 120 bcm over 2010, then China's carbon dioxide emissions would decrease by 520 million tons per year when compared to the same increase in the consumption of coal of the equivalent calorific value.¹⁰⁷ Similarly, the 13th Five-Year Plan for natural gas, published on December 24, 2016, states that if natural gas consumption reaches 360 bcm in 2020, an increase of 167 bcm from 2015, then carbon dioxide emissions would decrease by 710 million tons per year when compared to the same increase in the consumption of coal of the equivalent calorific value.¹⁰⁸

Measuring Greenhouse Gas Emissions

Beijing began to require China's NOCs to measure and report greenhouse gas emissions during the 12th Five-Year Plan period. The plan itself, which was the first to contain a carbon



emissions intensity reduction target (a 17 percent decline from 2010 levels by 2015), called for the development of a system to calculate and verify greenhouse gas emissions.¹⁰⁹ To this end, the National Development and Reform Commission (NDRC) issued a notice in March 2014 stating that all companies that emitted 13,000 tons or more of carbon dioxide equivalent in 2010 or consumed energy equivalent to 5,000 tons of standard coal or more must report their emissions of all six major greenhouse gases.¹¹⁰ The NDRC also prepared greenhouse gas accounting and reporting guidelines for 10 industries using the GHG Protocol Corporate Standard developed by the World Resources Institute and the World Business Council for Sustainable Development.¹¹¹ Two of the 10 industries were oil and natural gas production and petrochemicals.¹¹² One purpose of the industrial protocols is to support the development of China's ETS.¹¹³

Participating in Carbon Trading Pilot Projects

The 12th Five-Year Plan also set the goal of gradually establishing an ETS.¹¹⁴ In October 2011, the NDRC released Document 2601, which mandated the establishment of carbon trading pilots in seven cities and provinces.¹¹⁵ All seven pilots called for the participation of entities in China's petrochemical industry, while the Tianjin pilot also included oil and natural gas exploration to account for emissions from oil and gas operations in Bohai Bay.¹¹⁶

An ETS is a tool for putting a price on carbon. Participating companies must hold permits for every ton of CO₂ they emit. They can purchase, receive, and trade permits. At the end of each year, participating companies need to submit permits equal to their emissions.¹¹⁷

Anecdotal information indicates that the carbon prices from the pilots, which ran through 2020, probably were not high enough to spur emissions reductions by the NOCs. For example, Sinopec Corp. paid \$3.50 per ton of CO₂ in 2019 and \$4.00 per ton in 2020.¹¹⁸ These prices are just a small fraction of the \$40–\$80 per ton by 2020 and \$50–\$80 per ton by 2030 that the High-Level Commission on Carbon Prices chaired by economists Joseph Stiglitz and Nicholas Stern in 2017 said would be needed to meet the goals of the Paris Agreement.¹¹⁹

China's National Emissions Trading Scheme

China's national ETS started operating on July 16, 2021. It initially covers about 2,200 firms in the thermal power sector. PetroChina and Sinopec Corp. have a combined 31 power subsidiaries participating. The two NOCs are among the 10 SOEs that account for a large proportion of the covered emissions. The ETS will eventually cover firms in seven additional sectors (petrochemicals, chemicals, nonferrous metals, building materials, iron and steel, pulp and paper, and aviation.)¹²⁰

Firms participating in China's ETS have been allocated permits for carbon emissions for free. Lower-polluting companies can sell permits to higher-polluting companies. Unlike other ETSs, China's does not auction permits, have a fixed cap on emissions, or promise a declining cap over time. However, such features could be incorporated if Beijing decides to tighten the scheme.¹²¹



China's ETS targets emissions per unit of economic output rather than total emissions. As a result, absolute emissions can still increase as energy production increases provided firms are reducing emissions per unit of output. The focus on emissions intensity instead of absolute emissions may reflect an effort by Beijing to balance its climate and economic growth goals.¹²²

China's carbon market is unlikely to spur covered firms to curb their emissions, especially in the near term. The price of carbon permits opened at \$7.42 per ton and reached a high of \$8.18 per ton on the first day of operations.¹²³ For comparison, carbon traded around \$59 per ton in the European Union in mid-July 2021.¹²⁴ According to the 2020 China Carbon Pricing Survey, participants in China's carbon markets in July–August 2020 expect carbon permits to trade at around \$7.71 per ton and to increase to \$10.95 per ton in 2025 and \$10.95 per ton by 2030.¹²⁵

Concerns about “Runaway” Energy Demand Growth

The genesis of one of the carbon management activities of China's NOCs, improving energy efficiency, was the rapid increase in the country's energy demand in the early 2000s. China had just accomplished the unprecedented feat of quadrupling its gross domestic product (GDP) while only doubling its energy use between 1980 and 2000. No other major developing country has experienced declining energy intensity until much later in its development process.¹²⁶ Consequently, Chinese (and foreign) energy experts expected that China's energy demand would continue to grow more slowly than its GDP through 2020.¹²⁷

Much to the surprise of Beijing (and the rest of the world), China's energy consumption grew much more quickly than its GDP from 2002 to 2005.¹²⁸ Senior Chinese government officials viewed the rapid increase in China's energy demand as unsustainable due to the stress the construction of new energy supply infrastructure was putting on China's industrial system and environment. China's leaders were sufficiently alarmed such that in November 2005, the Politburo took the unusual step of issuing a mandatory target for energy intensity, which was subsequently incorporated into the 11th Five-Year Plan.¹²⁹ According to experts in the China Energy Group at Lawrence Berkeley National Laboratory, the fact that the Politburo set the type of target that is usually determined by the government instead of the party indicates just how alarmed China's leaders were by the increase in China's energy intensity.¹³⁰

China's government established the Top 1,000 Enterprise Program and the Top 10,000 Enterprise Program to support the achievement of the energy intensity targets of the 11th Five-Year Plan (20 percent reduction by 2010) and the 12th Five-Year Plan (16 percent reduction by 2015), respectively.¹³¹

The Top 1,000 program involved 1,008 firms that accounted for 30 percent of China's energy consumption in 2005, while the Top 10,000 program involved 14,641 firms that accounted for more than 60 percent of China's energy consumption in 2010.¹³² Both programs set specific energy conservation targets for firms, including the NOCs, and made target achievement a



component of performance evaluation for SOE leaders.¹³³

The Top 1,000 Enterprise Program surpassed its energy conservation goal by 50 percent. The program called for energy savings of 100 million tons of standard coal equivalent by 2010, and the companies saved 150 million tons of standard coal equivalent.¹³⁴ As a result, the Top 1,000 Enterprise Program contributed significantly to the achievement of China's goal of reducing its energy intensity by 20 percent below the 2005 level by 2010.¹³⁵

China's NOCs helped make the Top 1,000 Enterprise Program a success by exceeding their energy savings targets for the 11th Five-Year Plan period. A comparison of the targets and results by the companies' subsidiaries reveals that the companies saved substantially more energy than expected. For example, 31 CNPC subsidiaries had combined energy saving targets of 5.3872 million tons of standard coal equivalent. The actual amount of energy saved by these companies was 8.9577 tons of standard coal equivalent.¹³⁶

The Top 10,000 Enterprises Program also delivered more energy savings than expected. It achieved the energy savings targets for the 12th Five-Year Plan period (2011–2015) ahead of schedule. According to the NDRC, the Top 10,000 Enterprises Program had saved 309 million tons of standard coal equivalent by the end of 2014 compared to the target of saving 250 million tons of standard coal equivalent by the end of 2015.¹³⁷ The total energy savings of the Top 10,000 Enterprises Program for the 12th Five-Year Plan period has not been published.

Although Beijing implemented the Top 1,000 and Top 10,000 Enterprise Programs to moderate energy consumption, the two programs also aided the central government's initial efforts to slow the growth of China's GHG emissions. The Top 1,000 Enterprise Program reduced CO₂ emissions by approximately 350 million tons from 2006 to 2010, and the Top 10,000 Enterprise Program decreased CO₂ emissions by an additional 700 million tons from 2011 to 2015.¹³⁸ The 12th Five-Year Plan's carbon intensity targets reportedly were directly derived from the plan's energy intensity targets.¹³⁹

Concerns about Air Pollution

Beijing's fight against air pollution was the primary impetus for China's NOCs to pursue another energy transition activity: the expansion of China's natural gas supplies. Severe air pollution in the winter of 2012–2013, dubbed the “airpocalypse,” made improving air quality a higher priority for China's leaders. Indeed, then Premier Li Keqiang famously announced that “we will resolutely declare war against pollution” during a speech at the opening of the National People's Congress in March 2014.¹⁴⁰ President Xi Jinping underscored the ongoing importance of winning the fight against air pollution in remarks to the Central Committee for Financial and Economic Affairs in April 2018 in which he identified pollution as one of the “three tough battles” China must win along with poverty alleviation and the prevention of financial risks.¹⁴¹

The “airpocalypse” prompted Beijing to issue a series of policy documents that identified natural gas as a key “weapon” in China's fight for cleaner air. These documents also stipulated a central role for China's NOCs. Beijing tasked the NOCs with not only undertaking expensive refinery upgrades to produce cleaner fuels but also increasing the production of natural



gas and building the infrastructure needed to deliver growing volumes of natural gas to consumers.¹⁴²

On September 13, 2013, the State Council released the “Air Pollution Control and Prevention Action Plan” (the “Action Plan”).¹⁴³ Experts have described it as China’s “toughest ever clean-air policy.”¹⁴⁴ The Action Plan stipulated ambitious targets for reducing air pollutants between 2013 and 2017, with the strictest targets set for Beijing and the surrounding region. Specifically, it mandated that the Beijing-Tianjin-Hebei region lower particular matter (PM) 2.5 levels by 25 percent and that Beijing reduce PM 2.5 levels by 33 percent from 89.5 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) to 60 $\mu\text{g}/\text{m}^3$.¹⁴⁵ For comparison, the World Health Organization’s recommended average annual PM 2.5 level is 10 $\mu\text{g}/\text{m}^3$.¹⁴⁶

The central government enlisted China’s NOCs to help achieve the air pollution reduction targets in the Action Plan. On September 22, 2013, Wu Xinxiong, then a vice minister of the National Development and Reform Commission and the head of the National Energy Administration, convened a meeting with executives from the three NOCs and Datang Group (one of China’s five major power generation companies) to discuss the implementation of major energy projects intended to improve air quality in Beijing. The mission statement signed by Wu and the energy executives committed the companies to completing 36 projects aimed at expanding natural gas supplies, upgrading oil products, increasing the supply of electricity to eastern China, and developing renewable energy. CNPC agreed to undertake 10 projects including the construction of natural gas pipelines, storage, and a liquified natural gas (LNG) import terminal.¹⁴⁷

In May 2014, the National Development and Reform Commission, the National Energy Administration, and the Ministry of Environmental Protection (now the Ministry of Ecology and Environment) issued a work plan to guide the energy industry’s efforts to combat air pollution. It tasked the NOCs with increasing China’s natural gas supplies through development of the major projects that the NOCs had agreed to undertake. The work plan aimed to raise the share of natural gas in China’s energy mix to more than 7 percent in 2015 and more than 9 percent 2017. It also set goals for China’s “supply capacity” (a term that refers to the sum of domestic production capacity, pipeline import capacity, and the total volume of long-term LNG contracts) at 250 bcm in 2015 and 330 bcm in 2017.¹⁴⁸

Subsequent policy documents similarly called for China’s NOCs to help improve air quality. For example, in August 2017, a group of central, provincial, and local governments issued an air pollution control action plan for the Beijing-Tianjin-Hebei region for the fall of 2017 and the winter of 2018. The plan called for Beijing, Tianjin, and 26 other cities to retire coal-fired boilers and replace them, primarily with gas-fired ones.¹⁴⁹

In July 2018, the State Council published the “Three-Year Action Plan for Winning the Battle for Blue Skies,” which covered more cities than the Action Plan issued in 2013 but did not set more difficult targets.¹⁵⁰ The “Three-Year Action Plan” called for increasing the share of natural gas in China’s energy mix to 10 percent by 2020. It also called for continuing to build the country’s natural gas production, supply, storage, and marketing system and the replacement of coal-fired boilers with natural gas units, especially in the Beijing-Tianjin-Hebei region.¹⁵¹



Improving Air Quality: An Early Driver of Fuel Cell Vehicles

Beijing's concerns about air pollution have also been a primary impetus of another activity on the energy transition agendas of China's NOCs: expanding the use of hydrogen as a transportation fuel. Indeed, hydrogen refueling could reduce air pollution through the reduction of diesel use by trucks and ships. Other long-standing drivers include slowing the growth of China's oil imports and leapfrogging global competitors in an emerging industry.¹⁵²

All three motivations date to the turn of the century when China's Ministry of Science and Technology invited Wan Gang, an engineer working for Audi in Germany—who would later become China's minister of science and technology and the father of “China's electric vehicles”—to come back to China to devise a strategy for China's automobile industry.¹⁵³ Wan returned to China in 2000 and concluded that China would not be able to catch up with American, German, and Japanese manufacturers of automobiles powered by internal combustion engines. Instead, he determined that the fortunes of China's automobile industry lay in the development of new energy vehicles, a category that includes pure plug-in electric vehicles (EVs), hybrids, and fuel cell vehicles (FCVs) powered by hydrogen.¹⁵⁴

Wan succeeded in persuading China's government to back the unproven technology of EVs.¹⁵⁵ China's government has spent more than \$58.5 billion in the development of an EV industry, according to a report published by the Center for Strategic and International Studies in November 2018.¹⁵⁶ This investment helped China become the world's largest EV market.¹⁵⁷

That said, Wan first focused on FCVs upon his return to China. As the chief scientist and overall team leader of the major electric vehicle project of the national 863 Program (China's high-tech development strategy), Wan developed three FCV prototypes in the period 2003–2005.¹⁵⁸ But China's government initially opted to support hybrid and battery EVs over FCVs, perhaps due to the difficulties of promoting fuel cell technology in the early 2000s.¹⁵⁹

Wan remained a proponent of developing FCVs to combat air pollution after he became a vice-chairman of the Chinese People's Political Consultative Conference. In remarks to a forum on hydrogen energy at Tsinghua University on June 28, 2018, he recommended FCVs for heavy-duty trucks that drive long distances and face stricter environmental protection requirements.¹⁶⁰ FCVs address both issues. They can refuel in less than four minutes and have a driving range of 300 miles, similar to vehicles with internal combustion engines.¹⁶¹ In terms of environmental protection, FCVs have zero emissions, whereas diesel-powered trucks rank among the highest contributors to GHG emissions and street-level pollution.¹⁶²



Investor Pressure

Even though PetroChina, Sinopec Corp. and CNOOC Ltd. are majority owned by central state-owned enterprises, they are still under some pressure from equity markets to demonstrate their preparedness for the energy transition because they are, or were, listed on stock exchanges in Hong Kong and New York. (All three companies are listed in Hong Kong, and PetroChina and Sinopec Corp. are listed in New York. CNOOC was listed in New York until March 2021, when the New York Stock Exchange delisted it to comply with an executive order signed by former President Donald Trump.¹⁶³) To be sure, the pressure on China's NOCs from investors does not compare to that on European oil companies. That said, Hermes Investment Management's engagement with Sinopec Corp. and PetroChina demonstrates that both NOCs are responsive to some of the climate concerns of long-term institutional investors.¹⁶⁴ Hermes is an asset manager that enables such investors to be more active owners of their assets by engaging with companies on environmental, social, and governance issues including climate change.¹⁶⁵

In 2014, Hermes Equity Ownership Services (EOS) began to voice concerns to senior executives at Sinopec about the company's lack of information on its climate change strategy and risk mitigation measures.¹⁶⁶ Over the next few years, Hermes EOS continued to encourage Sinopec Corp. to set internal targets for the disclosure of information about its carbon emissions. Hermes EOS also repeatedly found opportunities to engage with Sinopec on climate change. For example, the asset manager supported the United Nations Global Compact seminar hosted by Sinopec Corp. to discuss its initiative on GHG reduction and disclosure, encouraged Sinopec Corp. executives to attend the first climate change training workshop held by the CDP in Beijing, and provided a shareholder view of the importance of climate change and the disclosure of emissions information. In 2018, Hermes EOS ran a workshop for Sinopec Corp. on the recommendations of the Task Force on Climate-related Financial Disclosures and discussed how Sinopec could analyze its portfolio resilience to several low-carbon scenarios.

Information provided by Hermes EOS indicates that Sinopec Corp. has taken a number of steps to respond to climate change since it began to engage with the asset manager. These actions include the following:¹⁶⁷

- Establishment of board oversight of climate governance by the social responsibility management committee, which was comprised of the then chairman Zhang Yuzhuo, then independent nonexecutive director Fan Gang and independent nonexecutive director Tang Min;¹⁶⁸
- Creation of several internal task forces to assess climate change-related risks and opportunities for incorporation into the company's longer-term business strategy;
- Release of the Green Enterprise Action Plan in April 2018 with specific targets for 2023, 2035, and 2050 (note that these are qualitative targets such as leading the world in green, low-carbon development by 2050);¹⁶⁹
- Introduction of a methane-reduction program and establishment of an undisclosed methane-specific reduction target; and



- Disclosure of its absolute level of carbon emissions by business division for the first time in 2018.

Hermes has engaged with PetroChina to share best practices on climate change.¹⁷⁰ In February 2019, representatives of Hermes met with senior representatives of PetroChina, including technical experts responsible for low-carbon transition technologies, to advocate for PetroChina to improve disclosure of its climate change strategy and risk management plan.¹⁷¹ This engagement reportedly contributed to PetroChina's disclosure of a climate change strategy and a plan to contribute to the goal of limiting climate change below 2°C.¹⁷²

Foreign Regulatory Requirements

Foreign jurisdictions require China's NOCs to manage greenhouse gas emissions. The companies operate in countries where emissions are regulated and carbon pricing exists, such as Canada and the United Kingdom. Consequently, China's NOCs participate in overseas carbon markets and invest in carbon offsets in other countries as part of their compliance obligations.

CNOOC Ltd. operates the Long Lake oil sands project in the Canadian province of Alberta, which has had carbon pricing since 2007 and had a carbon tax in 2018–2019.¹⁷³ The company complies with Alberta's carbon emissions reduction regime by reducing emissions through efficiency improvements, earning carbon credits through its ownership in the Soderglen wind farm in southern Alberta, and making payments of \$30 per ton into Alberta's Climate Change and Emissions Management Fund.¹⁷⁴ In terms of efficiency improvements, CNOOC Ltd. reduced the amount of energy required to extract one barrel of bitumen at its Long Lake facility by 40 percent between 2010 and 2019, which in turn significantly lowered the carbon intensity of Long Lake's bitumen production.¹⁷⁵

Oil platforms operated in the UK's offshore by CNOOC Ltd. and Repsol Sinopec Resources UK, a joint venture between Repsol and Sinopec Group, are covered by the European Union's emissions trading system (EU ETS). The data on greenhouse gas emissions published by both companies in annual environmental statements submitted to the UK government is more granular than the data on greenhouse gas emissions made publicly available by either CNOOC Ltd. or Sinopec Group in China. CNOOC Ltd. and Repsol Sinopec Resources UK report their annual carbon dioxide emissions on an installation basis, and Repsol Sinopec Resources UK also reports such data for its methane emissions.¹⁷⁶

Meanwhile PetroChina's investment in European refineries covered by the EU ETS prompted the company to form an emissions trading team, reportedly the first one set up in a Chinese company. In July 2011, PetroChina and INEOS, a global petrochemical manufacturer, established Petroineos, a refining and trading joint venture that owns the Grangemouth refinery in Scotland and the Lavéra refinery in France.¹⁷⁷ In October 2010, while PetroChina was negotiating with INEOS, the Chinese company hired Garth Edward, who previously ran Citigroup's global business in carbon trading and Kyoto emissions trading credits, to head its new UK-based emissions trading team.¹⁷⁸ According to an unnamed source close to PetroChina interviewed for a Chinese media report, the immediate impetus for PetroChina's establishment of an emissions trading team was to ensure that the company met its EU ETS obligations at the minimum cost. The same source said that PetroChina's decision to hire



Edward was also motivated by China's plans to develop a domestic emission trading system.¹⁷⁹

International Exposure

Before Xi announced the 30-60 goals, China's NOCs had already taken some steps toward a lower-carbon future as a result of exposure to the carbon management practices of multinational corporations. These practices provided China's NOCs with benchmarks against which to compare themselves. Comments by the NOCs indicate that their initial climate mitigation activities, notably developing the capacity to measure and report their greenhouse gas emissions, reflect both an ambition to prepare for the energy transition and a desire to bolster their reputations as responsible corporate citizens.

Preparing for the Energy Transition

Fu Chengyu, a former chairman of both CNOOC and Sinopec Group, developed an interest in reducing greenhouse gas emissions as a result of his dealings with foreign companies. He told a reporter who interviewed him for a story about his environmentalism published in December 2015 that in the 1980s foreign companies already knew how much carbon one air conditioner could emit while he was still wondering whether air conditioners had carbon emissions. Fu treated this discovery as a call to action, stating, "It is thus apparent that international corporations have long been doing it, yet we did not start until the 21st century. Therefore, environmental protection should be done as early as possible. Once we know what others are doing, we should catch up the soonest we can."¹⁸⁰

CNOOC inventoried greenhouse gas emissions under Fu's watch. The company's first sustainability report, for the year 2005, states that the company implemented greenhouse gas emissions reduction projects in onshore engineering projects and offshore oil fields in order to accumulate experience for larger-scale emissions reduction projects in the future.¹⁸¹ During 2007, CNOOC determined the CO₂ emissions of each of its oil and natural gas fields.¹⁸² The company later became the first central SOE to conduct a system-wide inventory of greenhouse gases that involved gathering data from more than 100 subsidiaries in 2010 and 2011.¹⁸³

Foreign companies also informed CNOOC's broader low-carbon agenda in the 2000s. Specifically, the growing importance of combatting climate change in the global business environment influenced Fu's push, beginning in the mid-2000s, to transform CNOOC from an oil company to an energy company by investing in renewable energy. Fu said as much to a reporter for the Chinese magazine *Green Living* in January 2021: "The main reason for this was that the international business community at that time, especially the manufacturing and energy companies in developed countries, already regarded climate change and carbon emission reduction as corporate social responsibility and ethical standards."¹⁸⁴

When Fu became chairman of Sinopec Group in 2011, he made several changes to prepare the company for a lower-carbon future. First, he incorporated a green and low-carbon strategy into the company's development strategy. Second, he created an energy and environmental management department to address the issues of energy efficiency, environmental protection, and carbon dioxide emissions reduction. Third, he launched a survey of Sinopec Group's carbon emissions that lasted three years. As a result, Sinopec Group "may be the first large



Chinese company that fully understands its carbon emissions,” according to Fu in an interview with a Chinese journalist in January 2021.¹⁸⁵

CNPC's participation in the OGCI is another example of how engagement with other multinational companies has shaped the energy transition activities of China's NOCs. The OGCI helped the company develop the capacity to report greenhouse gas emissions externally, which it began to do in 2019.¹⁸⁶ In addition, as an OGCI member, CNPC is required to contribute to the targets set by OGCI member countries to reduce the carbon and methane intensity of their aggregated upstream oil and gas operations. By the end of 2019, the OGCI had reduced its absolute methane emissions by 22 percent since 2017 and its absolute carbon emissions by 7 percent since 2017.¹⁸⁷

Burnishing Reputations

China's NOCs have also been motivated to engage in energy transition activities to burnish their reputations. For example, CNOOC became the first Chinese company invited to join Combat Climate Change, a global business leaders initiative, in 2007, and Fu reportedly viewed its membership in this organization as marking CNOOC's shift from being a “multinational business entity” to being a “responsible multinational business entity.”¹⁸⁸ When CNOOC launched its greenhouse gas emissions inventory project in September 2010, the company said that one of its objectives was to “become a widely respected responsible transnational entity.”¹⁸⁹ Both of these examples are consistent with Fu's long-standing view that companies need to be responsible corporate citizens in order to survive and thrive.¹⁹⁰

CNPC and PetroChina have similarly viewed participation in the OGCI as a way to develop a positive international image. Indeed, PetroChina identifies the absence of such an image as one of the climate-related risks it faces. The English language version of the company's *2019 Environmental, Social, and Governance Report* states: “A low-carbon image is an important indication of the influence of multinational companies and a major concern of stakeholders. If the Company fails to meet its low-carbon development goals or fails to meet such goals by the expected routes and measures, its reputation and image may be adversely affected.” The report also states that PetroChina is managing this risk through active participation in the global oil and gas industry's efforts to tackle climate change.¹⁹¹ Similarly, a CNPC executive wrote in 2018 that CNPC has developed a “responsible international image” through its participation in various OGCI activities such as the formulation of the “OGCI 2040 Low Emission Roadmap,” conducting surveys on methane emissions, and the establishment of evaluation standards for carbon dioxide storage capacity.¹⁹²



WHY CHINA'S NOCS DIDN'T DO MORE BEFORE THE 30-60 PLEDGES

The response of China's NOCs to climate change has been constrained by their role in China's political economy. Specifically, addressing climate change is one of multiple objectives China's leaders expect the NOCs to advance, and not necessarily the most important one. Enhancing oil and natural gas supply security and maintaining employment almost certainly ranked higher and still do. In addition, the NOCs have periodically faced headwinds in the form of profit targets set by the central government and periods of low oil prices.

The Oil and Natural Gas Supply Security Imperative

The most important objective the NOCs pursue for China's leaders is securing oil and natural gas for domestic consumption. China was the world's largest importer of crude oil and natural gas in 2019.¹⁹³ In 2020, China depended on imports for 73 percent of its crude oil and 43 percent of its natural gas.¹⁹⁴

Xi Jinping highlighted the centrality of the NOCs to Beijing's pursuit of supply security in July 2018 when he instructed China's oil companies to ramp up domestic exploration and production of oil and natural gas to ensure the country's energy security.¹⁹⁵ Xi's directive to the NOCs came at a time when China's crude output was in its third consecutive year of decline (from 4.3 million bpd in 2015 to 3.8 million bpd in 2018).¹⁹⁶ It was also consistent with a broader push for greater self-reliance amid trade tensions with the United States.¹⁹⁷

The three NOCs responded to Xi's directive by issuing their first ever seven-year plans for intensifying the exploration and production of domestic oil and natural gas in 2019–2025.¹⁹⁸ The broad objective of these plans is to stabilize oil production and increase natural gas production.¹⁹⁹ These goals reflect the fact that the prospects for boosting domestic output are brighter for natural gas than for oil because of the maturity of China's largest oil fields. China's NOCs achieved both objectives in 2019, which saw the country's oil output grow by 0.9 percent and its natural gas production increase by 9.8 percent.²⁰⁰ (For comparison, in 2019, China's apparent oil consumption increased by 5.2 percent, and its apparent natural gas consumption grew by 9.4 percent.²⁰¹) The companies delivered again in 2020, with China's oil production increasing by 1.6 percent and its gas production growing by 9.8 percent.²⁰²

PetroChina, the country's largest producer of oil and natural gas, often highlights its responsibility to ensure stable supplies in its sustainability reports. For example, after shortfalls in pipeline gas deliveries from Turkmenistan and the aggressive implementation of “coal-to-gas” switching for heating in northeastern China during a colder than usual winter resulted in natural gas shortages in 2017, PetroChina's *2017 Sustainability Report* stated that it ensured maximum gas production, maximum unloading capacity at LNG terminals, and maximum gas storage volume to secure stable supplies.²⁰³

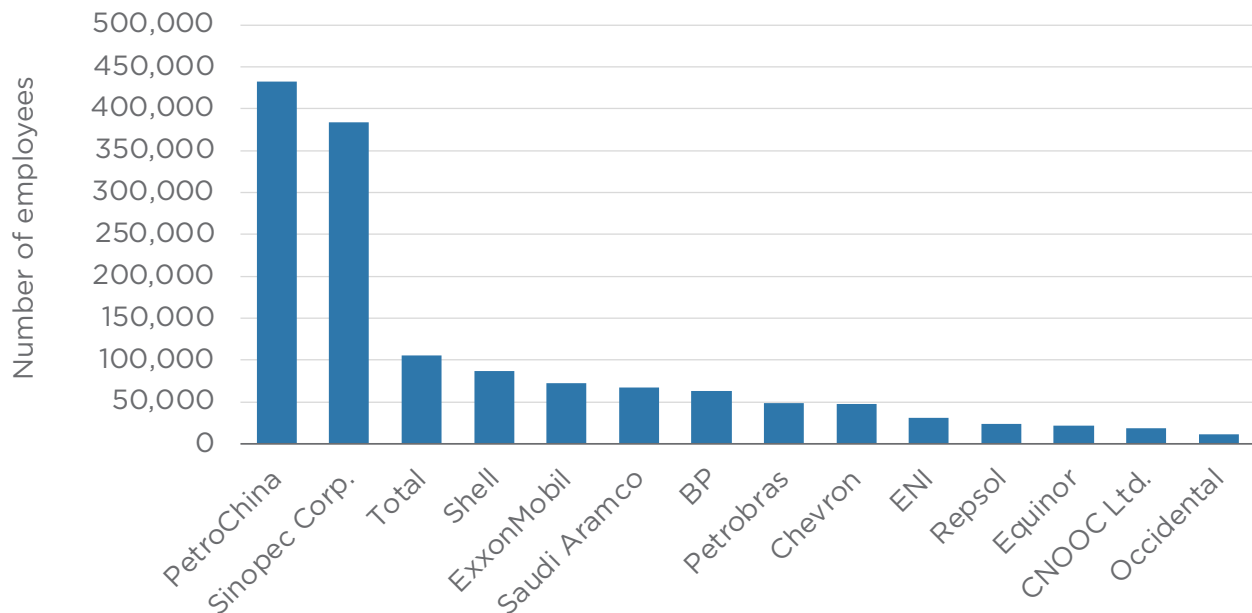


The Employment Imperative

China's NOCs, notably CNPC and Sinopec Group, have a responsibility to keep people employed. The need to maintain, and even grow, their workforces constrains the extent to which—and certainly the pace at which—the NOCs can pivot away from oil and natural gas production.²⁰⁴ To be sure, as the International Energy Agency argued in its report, *Net Zero by 2050*, the oil and natural gas industry has skills and resources that are a good fit with some of the technologies needed to reduce greenhouse gas emissions, such as CCUS, hydrogen, and offshore wind power. However, transitioning employees from exploring and producing oil and natural gas to developing low-carbon fuels and technologies undoubtedly will take some time. If such a transition occurs in China, it almost certainly will proceed gradually to avoid large-scale layoffs or unemployment.

China's NOCs, and their respective flagship subsidiaries, have enormous numbers of employees. As of December 31, 2020, PetroChina employed 432,003 people, Sinopec Corp. employed 384,065, and CNOOC Ltd. employed 18,353.²⁰⁵ For comparison, as of August 2021, CNPC employed 1,242,245 people (including PetroChina employees), Sinopec Group employed 553,833 (including Sinopec Corp. employees), and CNOOC employed 80,058 (including CNOOC Ltd. employees).²⁰⁶ These head counts are much larger than those of other leading oil companies (see Figure 7). For example, ExxonMobil employed 72,000 people and Royal Dutch Shell employed 87,000 in 2020.²⁰⁷

Figure 7: Employees of select oil companies in 2020



Source: See appendix.



The importance of China's NOCs as sources of employment is highlighted by Beijing's use of central SOEs to hire more workers in the wake of the COVID-19 pandemic to support economic recovery and social stability. In March 2020, SASAC issued a notice urging central SOEs to create more jobs, especially for recent college graduates, migrant workers, and laborers from poor areas.²⁰⁸ The NOCs responded by announcing plans to step up their hiring, especially of new graduates. One media report estimated that the three NOCs would hire about 20,000 college graduates in 2020, 90 percent more than in 2019.²⁰⁹

Similarly, an exchange between Xi Jinping and Jiang Wanchun, the Communist Party secretary of PetroChina's Daqing oil field, during the annual meeting of China's National People's Congress in March 2016, highlights the importance China's top leader attaches to the NOCs as sources of employment.²¹⁰ Jiang, then the highest-ranking official at Daqing, reported to Xi that the oil field, which is owned by PetroChina, had lost around \$800 million in the first two months of 2016 due to low oil prices. (The spot price for Brent crude averaged \$31 per barrel in January and \$32 per barrel in February, far below Daqing's production cost of \$45 per barrel.²¹¹) Xi responded by inquiring whether the workforce was stable and their salaries guaranteed despite the difficult operating conditions. Jiang replied that the jobs and salaries of "frontline" workers were safe. Xi then stated that structural adjustment cannot be made at the expense of employee interests and that the income and treatment of frontline employees must be guaranteed.

Wang Yilin, then the chairman of the board of CNPC and PetroChina, subsequently underscored Jiang's comment about the job security of oil workers. During a meeting with the Chinese media on the sidelines of the National People's Congress in March 2016, Wang made clear that letting people go in tough times isn't an option. He said that CNPC was not like international oil companies because it would not undertake large-scale layoffs to cut costs in response to low oil prices.²¹²

Financial Pressures

China's NOCs are subject to financial pressures that can impact their climate actions. These include domestic regulatory pressures such as profit targets set by SASAC. Market pressures, such as the price of crude oil, have also affected the climate mitigation activities of China's NOCs.

Profit Targets

SASAC conducts annual and triennial performance reviews of central SOE executives. The basis for the assessment is the previous period's performance. At the beginning of each year and three-year term, SOE executives and SASAC sign an annual performance agreement that details performance goals, evaluation criteria, and rewards and punishments.²¹³ The performance indicators used by SASAC include net profits and economic value added.²¹⁴

In June 2019, SASAC announced that central SOEs had agreed to boost their annual net profits by 9 percent in 2019. SASAC further stated that a subset of 20 companies, including CNPC, pledged to achieve 12 percent growth in net profits in 2019. The new net profit goals were incorporated into the central SOEs' performance agreements for 2019. SASAC hosted



a performance agreement signing ceremony on June 12, where SASAC Party Committee Secretary and Director Hao Peng requested that the SOEs do their part to help stabilize China's economy.²¹⁵

Oil Prices

The price of oil influences the climate actions of China's NOCs. Carbon capture and storage for enhanced oil recovery (CCS-EOR) is a case in point. High oil prices provide an incentive to invest in CCS-EOR while low oil prices do not. One proposed CCS-EOR project that fell victim to the crude oil collapse in the mid-2010s was Sinopec's plan to capture carbon dioxide from a power plant for injection into the company's Shengli oil field. Sinopec delayed making the final investment decision because the project economics did not meet its investment criteria. Indeed, Sinopec calculated that the internal rate of return for the project was just 5.6 percent when the price of crude oil was \$70 per barrel in November 2014, below the minimum rate of return acceptable to the company. (One Chinese analysis of this project indicated that the minimum acceptable rate of return for the project was 8 percent based on the fact that CNPC's economic evaluation parameters of construction projects [2013] requires the after-tax internal rate of return for special onshore oil field development to be at 8 percent.)



WHAT THE 30-60 TARGETS MEAN FOR CHINA'S NOCS

China's ambition to peak carbon emissions before 2030 and to achieve carbon neutrality before 2060 is putting pressure on the country's central SOEs, especially ones in high-carbon emission industries, to help the country achieve its climate targets. During December 16–18, 2020, the Central Economic Work Conference, an annual meeting at which China's leaders determine their economic priorities for the following year, convened in Beijing and identified “carrying out carbon peaking and carbon neutrality work” as one of eight key tasks for 2021.²¹⁶ One week later, at a meeting of the heads of central SOEs during December 24–25, SASAC announced that engaging in carbon peaking and carbon neutrality activities would be a key task for central SOEs in the following year.²¹⁷

During a press conference on April 16, 2021, SASAC secretary-general and spokesperson Peng Huagang reminded central SOEs of their responsibility to help China realize its climate ambitions. He called on the firms to “contribute to the power of central SOEs in achieving the carbon peaking and carbon neutrality goals.” He also said that SASAC would formulate policies to guide central SOEs in implementing “carbon peaking and carbon neutrality” requirements.²¹⁸

In the meantime, numerous central SOEs announced plans to achieve carbon peaking (see Table 6) and carbon neutrality ahead of China's 30-60 goals. On March 25, 2021, PetroChina, which had already set a near-zero emissions goal for 2050, announced that it is aiming for peak carbon emissions by 2025. Four days later, Sinopec Corp. revealed that it is targeting peak carbon emissions by 2025 and carbon neutrality by 2050, making it one of a handful of central SOEs to set a midcentury target.

Table 6: Carbon peaking targets of select central SOEs

Date announced	Company	Peaking year
December 8, 2020	State Power Investment Corporation	2023
December 20, 2020	China Energy Investment Corporation	2023
January 21, 2021	BaoWu Steel Group	2023
January 21, 2021	China Datang Group	2025
January 28, 2021	China Huadian Group	2025
March 12, 2021	China Three Gorges Corporation	2023
March 18, 2021	China Resource Power Corporation	2025
March 25, 2021	PetroChina	2025
March 29, 2021	Sinopec Corp.	2025
June 8, 2021	Chinalco	2025

Source: See appendix.



China's NOCs have also engaged in a variety of activities to demonstrate their commitment to the 30-60 goals. For example, on November 23, 2020, Sinopec Group signed a letter of intent for strategic cooperation with the NDRC's Energy Research Institute, the National Center for Climate Change Strategy and International Cooperation, and Tsinghua University's Laboratory of Low-Carbon Energy to jointly research a strategic path for Sinopec to take the lead in carbon peaking and carbon neutrality in the energy and chemical industries.²¹⁹ In January 2021, CNOOC announced the official launch of its carbon neutrality plan, established a research institution to formulate a road map for reducing carbon emissions and a carbon neutrality target, and created a new subsidiary to focus on the development of new energy technologies with offshore wind power as its primary focus.²²⁰ In April 2021, CNPC announced that it is reorganizing its headquarters to reflect the increased importance the company now attaches to renewables and low-carbon technologies, a development that is discussed in more detail below.

These expressions of support for the 30-60 goals belie the likelihood that producing oil and natural gas will probably remain the primary remit of China's NOCs at least through 2030, the year before which China intends to peak its emissions. The chairmen of the three NOCs have said as much. They have also indicated that they intend to increase the share of natural gas in their production mixes, a shift they regard as helping China to transition to a lower-carbon future. (As CNPC Chairman Dai Houliang told China Central Television in February 2021, "coal is high-carbon, oil is medium-carbon, and natural gas is low-carbon."²²¹) That said, the three NOCs, aware that they eventually may need to expand their core business area beyond hydrocarbons, will continue to explore ways to decarbonize their operations and provide consumers with lower-carbon alternatives with a focus on areas where they have comparative advantages.

Oil and Natural Gas Likely to Remain the Core Business

Oil and natural gas almost certainly will remain the core business of China's NOCs through at least 2030. China's demand for and imports of oil and natural gas are likely to increase during this period. As a result, the primary responsibility of the three NOCs is likely to continue to be ensuring China's oil and natural gas supply security.

CNPC, China's largest oil and natural gas producer, expects the country to consume and import larger volumes of oil and natural gas. In April 2021, CNPC's Economics and Technology Research Institute released the 2020 version of its *Domestic and Foreign Oil and Gas Industry Development Report*. A summary of the report's projections of China's oil balance through 2025 by a newspaper owned by CNPC states that China's oil demand will increase from 14 million bpd in 2020 to 14.6–15 million bpd in 2025, the year around which the company expects China's oil demand to peak. If China's domestic oil production continues to be around 4 million bpd (the summary does not contain a production figure), then China's oil imports will be 10.6–11 million bpd in 2025. The report also expects that between 2020 and 2025, China's natural gas demand will grow from 326 bcm to 420–500 bcm and that its natural gas imports will increase from 133.6 bcm to 170–275 bcm (see Table 7).²²²



Table 7: CNPC's projections of China's oil and natural gas balance through 2025

	2020	2021	2025
Oil (million barrels per day)			
Demand	14.0	14.2	14.6–15.0
Production	3.9	4.0	4.0
Imports	10.1	10.2	10.6–11.0
Natural gas (billion cubic meters)			
Demand	326.0	354.0	420.0–500.0
Production	193.0	204.0	235.0–250.0
Imports	134.0	150.0	170.0–275.0

Source: See appendix.

Meanwhile, in November 2020, CNPC Chairman Dai Houliang provided an additional explanation for why his company has no immediate plans to alter the status of oil and natural gas exploration and production as CNPC's primary business. In remarks at an international oil and gas conference, he stated that hydrocarbons emit less carbon dioxide than coal. Consequently, oil and natural gas will remain the core business of CNPC for some time to come.²²³

During an appearance on China Central Television's Dialogue program in April 2021, Sinopec Group's then chairman, Zhang Yuzhuo, said that his company will remain an oil and natural gas producer even as it offers lower-carbon alternatives to customers. In response to a question about whether hydrogen will be the ultimate solution for carbon neutrality, he replied, "Ultimately, for Sinopec, hydrogen may not be able to fully undertake the task because Sinopec itself is a supplier of energy and material. We are an energy and chemical company. In the field of energy, oil and gas may still be needed for a long period of time in the future. We will meet everyone's demand for oil and gas. In this process, we will accelerate the introduction of hydrogen and electricity to replace traditional petroleum products. So the scenario is going to be that, in the future, Sinopec will provide oil, gas, hydrogen, and electricity plus integrated services."²²⁴

CNOOC CEO Wang Dongjin similarly stressed the continued primacy of oil and natural gas production in his company's operations in an essay he penned for the March 18, 2021, issue of *China Energy News*. Wang states that CNOOC will "unswervingly implement the seven-year action plan for increasing domestic oil and natural gas reserves and production to demonstrate CNOOC's efforts to ensure national energy security and at the same time provide strength for the energy transition." He subsequently noted that his company will promote the clean energy transition in the longer term.²²⁵

China's leaders also foresee a continued role for oil and natural gas in China's energy mix. In November 2020, the Central Committee of the Communist Party of China released its



recommendations for the contents of the 14th Five-Year Plan (2021–2025), which include strengthening domestic oil and natural gas development and accelerating the construction of oil and natural gas storage facilities and pipelines.²²⁶ In March 2021, the National People's Congress approved the “Outline for the 14th Five-Year Plan and Long-Term Targets to 2035.” Unlike the 13th Five-Year Plan, the 14th Five-Year Plan (2021–2025) devotes a stand-alone section to energy security, which is focused on hydrocarbons. This section states that “the core demand for oil and gas should rely on self-sufficiency” (a recommendation that is absent from the 13th Five-Year Plan). It also calls for maintaining and increasing oil and natural gas production.²²⁷

Another reason that oil and natural gas are likely to remain the core business of China's NOCs is the competition in the renewable energy sector from private firms and China's state-owned power generation companies, which had established themselves as the dominant players in China's renewable energy industries before the NOCs began to pursue wind and solar projects. As Peng Peng, secretary-general of the China New Energy Investment and Finance Alliance said in an interview with Chinese media in October 2020, most areas suitable for onshore wind power have already been developed, with 80 percent of the high-quality projects in the hands of state-owned generation companies.²²⁸ Similarly, before CNOOC returned to the offshore wind market in 2019, a group of central SOEs including the China General Nuclear Power Corporation, China Three Gorges Corporation, and State Power Investment Corporation had established themselves as the leaders in the development of offshore wind power.²²⁹ Central SOEs are also moving into the solar business to help China decarbonize.²³⁰ In 2020, state-owned generation companies were the main drivers of the 178 percent year-on-year increase in solar power capacity (48.2 gigawatts of new capacity, the most since 2017) and the 60 percent year-on-year growth in wind power capacity (71.1 gigawatts of new capacity, twice the previous high).²³¹

A Shift from Oil and Gas Companies to Gas and Oil Companies

China's aim to become carbon neutral by 2060 is likely to reinforce a shift already underway in the companies' production mixes from oil to natural gas. In 2020, CNPC's production of natural gas exceeded its production of oil for the first time.²³² This shift to producing more natural gas is also occurring at Sinopec Group and CNOOC. The share of natural gas increased in each company's domestic production mix between 2016 and 2020 (see Table 8).

Table 8: The shifting domestic production mixes of China's NOCs

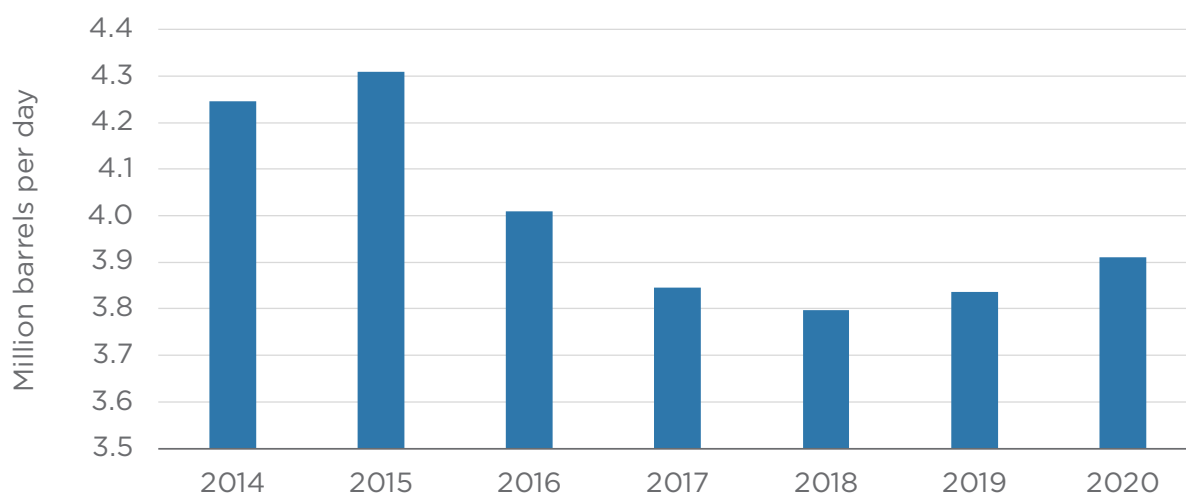
	2016		2020	
	Oil	Natural gas	Oil	Natural gas
CNPC	56%	44%	48%	52%
Sinopec Group	66%	34%	57%	43%
CNOOC	80%	20%	73%	27%

Source: See appendix.



The NOCs' transition from oil and gas companies to gas and oil companies is being driven by geology and policy. In terms of geology, production at China's oldest and largest oil fields, including Daqing and Shengli, is in decline.²³³ Finding replacement reserves has been difficult, with one NOC manager quipping that "without rice in hand, you can't make a meal."²³⁴ As a result, it has been difficult for China's NOCs to maintain—let alone substantially grow—oil production (see Figure 8).

Figure 8: China's oil production



Source: See appendix.

In terms of policy, Beijing's push to reduce air pollution underpins its commitment to expanding not only China's natural gas consumption but also its production. China's government targeted an increase in the share of natural gas in China's energy mix from 5.9 percent to 8.3–10 percent between 2015 and 2020 and an increase in China's natural gas production from 135 bcm to 207 bcm over the same period.²³⁵ (China achieved the first goal but not the second.) Ongoing efforts to improve air quality will support the expansion of China's natural gas demand and supply during the 14th Five-Year Plan period.²³⁶

China's carbon neutrality goal provides another incentive for China's NOCs to produce more natural gas. Several NOC executives have stated that this is one of the ways their companies will support the 2060 carbon neutrality goal. For example, in October 2020, CNOOC Ltd.'s chief financial officer, Xie Weizhi, told reporters that CNOOC Ltd. planned to increase the share of natural gas in its production mix from 21 percent in 2020 to 50 percent by 2035 to contribute to China's carbon neutrality target.²³⁷ In November 2020, then Sinopec Group chairman, Zhang Yuzhuo, told participants in the Bloomberg New Economy Forum that Sinopec regards natural gas as the most important energy resource to develop during the transition period.²³⁸



In April 2021, Zhang Rongwang, deputy general manager of CNOOC Gas and Power, told an industry forum that the use of natural gas should be accelerated during the 14th and 15th Five-Year Plan periods (2021–2030) to help China peak carbon emissions before 2030 and to buy more time to realize the 2060 carbon neutrality goal. According to Zhang, nonfossil energy cannot fully satisfy China's energy demand in the short-term due in part to the need for technological breakthroughs in energy storage and hydrogen. Consequently, in Zhang's view, natural gas is a realistic choice to ensure energy security and support the transformation of China's energy structure in the near future.²³⁹

CNPC has made natural gas the centerpiece of its emerging energy transition strategy, a move consistent with its status as China's largest natural gas producer. In March 2021, during PetroChina's annual results briefing, Chairman Dai Houliang stated that the company's first step toward lowering its emissions is to increase natural gas production with the aim of expanding its share of the company's production mix to 55 percent by 2025.²⁴⁰ (Natural gas accounted for 47 percent of PetroChina's production mix in 2020.²⁴¹)

Movement on Methane

China's NOCs are aware that methane emissions need to be controlled in order for natural gas to serve as a bridge to a lower-carbon future. To this end, CNPC, Sinopec Group, CNOOC, and four other Chinese oil and natural gas companies (Beijing Gas Group Co., Ltd.; China Resources Gas Group Ltd.; ENN Energy Holdings Ltd.; and China Oil and Gas Pipeline Network Corp.) established the China Oil and Gas Methane Alliance in May 2021. According to CNPC, acting as the alliance's first president, the group will serve as a platform for exchanging best practices, promoting emissions control standards, and improving the standardization and transparency of emissions data. The member companies aim to reduce the average methane intensity of their natural gas production to below 0.25 percent by 2025 from an unidentified level and reach an undefined "world-class level" by 2035.²⁴² (For comparison, the OGCI member companies aim to lower their collective upstream methane intensity to 0.20 percent by 2025, down from 0.23 percent in 2019.²⁴³)

In addition, Sinopec Corp. became China's first NOC to publicly report methane emissions. The company's *2020 Sustainability Report* states that Sinopec Corp.'s methane emissions in 2020 were 283.56 million cubic meters, with the company's oil and natural gas exploration segment accounting for 245.98 million cubic meters.²⁴⁴

Expanding beyond Oil and Natural Gas

China's NOCs are likely to contribute to the 30-60 goals by continuing to explore ways to expand their core business area beyond oil and natural gas. The NOCs' recognition that they might have to broaden the scope of their operations to adapt to a decarbonizing world is reflected in the types of companies the NOCs have said they want to become:²⁴⁵

- An integrated energy supplier (CNPC),



- An international first-class energy company with Chinese characteristics (CNOOC), and
- A world-leading clean energy and chemical company (Sinopec Group)

The NOCs' blueprints for translating these visions into reality are works in progress. Sinopec Group and CNOOC are focusing on hydrogen and offshore wind power, respectively, which build off of existing areas of expertise. Although CNPC's plans are vaguer, the company has signaled that it intends to devote more resources to supporting China's carbon peaking and carbon neutrality goals.

CNPC: Restructuring for the Energy Transition

CNPC is making structural changes that indicate the company is planning to step up its participation in the energy transition. On April 8, 2021, CNPC announced a plan to reorganize its nine business lines into four new ones, including "oil and natural gas and new energy."²⁴⁶ (According to CNPC, "new energy" includes geothermal energy, gas hydrates, biomass, energy storage, hydrogen fuel, and uranium.²⁴⁷) An unnamed company official told an industry publication that the reorganization "is the strategic choice for CNPC to better follow the global energy transition trend."²⁴⁸ Indeed, industry analysts interpreted the reorganization as a sign that CNPC had elevated the strategic importance of new energy to the same level as oil and natural gas.²⁴⁹ The merging of the oil and natural gas and new energy divisions is also consistent with Chairman Dai Houliang's statement in November 2020 that CNPC would promote the creation of a "'low-carbon energy ecosystem' in which fossil fuels and new energy are fully integrated, to enable the company to stay highly competitive during the transition."²⁵⁰

CNPC also intends to create an investment vehicle to support its "green and low-carbon development," according to a filing PetroChina made with the Hong Kong stock exchange on April 29, 2021. The new company, CNPC Kunlun Capital, will be a joint venture between CNPC (51 percent), PetroChina (29 percent), and CNPC Capital (20 percent), CNPC's financial services arm. The three shareholders have committed to injecting \$1.5 billion into the new investment vehicle within three years.²⁵¹

Meanwhile, PetroChina executives provided more information about PetroChina's plans to achieve near-zero emissions by 2050 during its midyear earnings call in August 2021. Chairman Dai stated that PetroChina aims for new energy, oil and natural gas to each account for one-third of the company's capital expenditure by 2035. He also spoke of continuing to exploit wind and solar resources at the company's oil fields, investing in more geothermal projects and developing "a series of technologies around CCS and CCUS." Executive director and president Huang Yanzhong said PetroChina will look for new opportunities in hydrogen.²⁵²

CNOOC: Prioritizing Offshore Wind

CNOOC Ltd. has increased the share of its budget that it invests in low-carbon energy. On August 19, 2021, chairman Wang Dongjin said the company intends to spend 5 to 10 percent of its total annual capital expenditure on low-carbon projects in 2021–2025, up from the 5 percent announced in early 2021.²⁵³ CNOOC Ltd.'s planned capital expenditure for 2021 is RMB 90–100 billion (\$13.9–\$14.5 billion).²⁵⁴



Wang stated that CNOOC Ltd.'s low-carbon energy investments will continue to focus on offshore wind. However, the company will also invest in onshore wind and solar power. Wang also said that the company expects to have non-fossil energy generate more than half of its earnings by 2050.²⁵⁵

Sinopec Group: Betting on Hydrogen and CCUS

Since Xi announced the 30-60 targets, Sinopec Group has made it increasingly clear that the company's plans for the energy transition involve playing a larger role in the development of two industries critical to the decarbonization of China and the world: green and blue hydrogen and CCUS. The company is positioned to make contributions in both areas, given its status as China's largest refiner and hydrogen producer, the integration of its upstream and downstream operations, and the professional background of its former chairman (see the text box at the end of this section).

Hydrogen

Sinopec Group's preparations for a lower-carbon future center on hydrogen. Indeed, its former chairman, Zhang Yuzhuo, spoke frequently of transforming the company into China's leading hydrogen energy company.²⁵⁶ During Sinopec Corp.'s earnings call with investors and analysts on March 29, 2021, Zhang announced that "hydrogen is at the core of Sinopec's low carbon business transformation." During the company's midyear earnings call on August 30, 2021, Sinopec Corp.'s president, Ma Yongsheng, doubled down on the company's commitment to making hydrogen the focus of its energy transition strategy when he unveiled plans to invest \$4.6 billion in the development of China's largest supply chain for automotive hydrogen.²⁵⁷

Ma reiterated the goal previously announced in February 2021 by Sinopec Group's newspaper, *China Petrochemical News*, of opening 1,000 hydrogen refueling stations (HRSs) in China by 2025.²⁵⁸ (For comparison, there were 100 HRSs in China and 650 HRSs worldwide at the end of 2020.²⁵⁹) According to Ma, the 1,000 HRSs will have an overall service capacity of 200,000 tons per year by the end of 2025.²⁶⁰

Ma also indicated that Sinopec Corp. will stick with the plan, previously outlined by former chairman Zhang, to shift from using fossil fuels to using wind and solar to produce hydrogen.²⁶¹ Specifically, the company aims to develop green hydrogen production capacity of more than one million tons per year by 2025.²⁶² To this end, Sinopec Group has sought partnerships with foreign and domestic firms.²⁶³ The company intends to launch its first green hydrogen project with a production capacity of 10,000 tons per year in Inner Mongolia in 2022 and is planning to build another green hydrogen project with an annual production capacity of 20,000 tons per year.²⁶⁴

During the conference call, Ma reminded analysts of why Sinopec Corp. is well-positioned to become China's top hydrogen company. He said that, as a major energy company, Sinopec Corp. has "accumulated rich experience and technological advantages" in the production and use of hydrogen. Ma also said that the company's more than 30,000 service stations give it an edge in the distribution of hydrogen.²⁶⁵



CCUS

On July 5, 2021, Zhang revealed his ambition for Sinopec Group to play a much larger role in the development of China's CCUS industry with his announcement that the company had begun construction of China's largest CCUS project (1 million tons) in Shandong province and that the project is expected to go into production by the end of 2021.²⁶⁶ The project will capture CO₂ produced by the company's Qilu refinery during a hydrogen-making process and inject it into the Shengli oil field to enhance oil production. According to Sinopec Group, over the next 15 years, the project will inject 10.68 million tons of CO₂ into the oil field and increase oil production by around 2.97 million tons (about 4,000 bpd).²⁶⁷

Comments by Zhang make it clear that the Qilu-Shengli CCUS project intends to lay the groundwork for the construction of additional, large-scale CCUS projects in China by Sinopec Group and other companies by providing engineering experience and technical data.²⁶⁸ Zhang said that during the 14th Five-Year Plan period, Sinopec Group will construct additional megaton projects that will capture CO₂ from the company's refineries and petrochemical plants in Jiangsu and inject it into the company's Jiangsu and Huadong oil fields.²⁶⁹

Will Sinopec Become China's Leading Hydrogen Company?

Former Sinopec Group Chairman Zhang Yuzhuo's professional background, Sinopec's hydrogen experience and infrastructure, and the growing interest in green hydrogen domestically and internationally as a decarbonization technology have laid the groundwork for Sinopec to achieve its goal of becoming China's leading hydrogen company.

Zhang's background: Zhang is a technical expert in gasification, which is important to the development of low-carbon blue hydrogen in China.²⁷⁰ He was probably the only central SOE executive with experience making blue hydrogen from gray hydrogen. When he was president of the coal liquefaction company of Shenhua Energy, China's largest coal company, Zhang oversaw the development of China's first and only project that combines coal liquefaction with carbon capture and storage.²⁷¹ And in his position as party secretary of the Tianjin Binhai New District, Zhang encouraged the zone to develop emerging industries such as hydrogen fuel cells and new energy vehicles.²⁷²

Sinopec's advantages: Sinopec Group has experience producing, storing, transporting, and using hydrogen due to its status as China's largest refiner.²⁷³ One of the reasons Zhang stated for his confidence that Sinopec can become China's leading hydrogen company is its acceleration in building the necessary infrastructure for hydrogen,²⁷⁴ including at Sinopec Group's network of more than 30,000 service stations nationwide. Also, Sinopec is essentially its own power company and can build and buy wind and solar plants, which can be used to make green hydrogen.²⁷⁵

High-level interest: Zhang assumed the chairmanship of Sinopec Group in January 2020, during a time of increasing interest in hydrogen at home and abroad. For example,



in June 2019, Wan Gang—the former Audi executive turned minister of science and technology mentioned earlier in this paper—urged China to invest in the infrastructure for distributing hydrogen as a fuel to spur the development of China’s fuel cell industry.²⁷⁶ In March 2021, China’s 14th Five-Year Plan identified “hydrogen energy and energy storage” as one of six future industries to be developed.²⁷⁷ Additionally, China’s growing interest in hydrogen is occurring against the backdrop of a global competition to develop cost-competitive technologies to produce green hydrogen and secure export opportunities.²⁷⁸

Possible roadblocks: Sinopec may face several challenges in its quest to become China’s leading hydrogen company, including bottlenecks in core technologies such as liquid hydrogen storage, high-end materials, and equipment manufacturing; the high cost of producing green hydrogen; and insufficient policy support.²⁷⁹ There is also the risk that not all of the carbon dioxide generated from the production of blue hydrogen will be captured and stored.²⁸⁰



CONCLUSION

The 30-60 targets have created a new mandate for China's NOCs to contribute to the country's efforts to peak carbon emissions before 2030 and achieve carbon neutrality before 2060. The higher priority Xi himself attaches to decarbonization has also made it a higher priority for China's NOCs. As Li Peng, the director of strategic management at another central SOE, State Power Investment Corporation, said in May 2021, "carbon neutrality is a central responsibility of state-owned enterprises."²⁸¹

The carbon peaking and carbon neutrality goals mean China's NOCs must balance supporting the Chinese leadership's energy transition agenda with advancing its oil and natural gas supply security agenda. To be sure, in the longer term, decarbonization should enhance China's energy supply security by shrinking the role of imported fossil fuels in China's energy mix. However, in the shorter term, the NOCs are trying to thread the needle of preparing for the energy transition at a time when concerns about fossil fuel supply security are elevated in Beijing as indicated by the greater emphasis on this issue in the 14th Five-Year Plan. In short, oil and natural gas supply security almost certainly will remain job number one for the NOCs, but the companies almost certainly will have to continue to demonstrate support for the 30-60 goals too.

The leaders of the three NOCs have indicated that they initially intend to further their decarbonization and energy supply security agendas by focusing on what is arguably the greatest area of overlap: increasing natural gas production. Natural gas is regarded by China's NOCs as a "low carbon" fuel (as compared to coal and oil) that can have intermediate climate benefits if it backs out coal and methane emissions are managed. Since China's geology and Beijing's war on air pollution were already pushing the NOCs in this direction, it is not surprising that the three companies have chosen to make virtue of necessity by giving plans to grow natural gas production—and the share of natural gas in their production mixes—a prominent place in their low-carbon development plans. Moreover, increasing China's natural gas output is featured in the inaugural seven-year plans to expand China's domestic oil and natural gas reserves and production that the NOCs drafted in response to Xi's instruction in July 2018 to enhance national energy supply security.

By identifying increasing natural gas production (and increasing the share of natural gas in their production mixes) as an initial focal point of their emerging energy transition strategies, the NOCs buy themselves some time to figure out how they might be able to best position themselves to survive and thrive in a world where oil and natural gas play smaller roles in China's energy mix. It is unlikely that the companies will stop producing oil and natural gas or that oil and natural gas will cease to be a—if not the—core business. But the NOCs are aware that they almost certainly will need to continue to flesh out their responses to the energy transition. These responses likely will include additional investments in low-carbon hydrogen and CCUS, technologies needed to get China and the world to net-zero emissions.

This report yields three additional insights about the NOCs' energy transition strategies.



First, there is likely to be considerable support for energy transition activities that also advance other priorities of China's leadership. Increasing natural gas output, which also helps improve air quality and enhance energy supply security, is a case in point. The production of blue or green hydrogen is likely another example. Not only would it help reduce air pollution and bolster energy security but hydrogen is also one of six future industries listed in the 14th Five-Year Plan that Beijing wants to develop.

Second, central SOE executives can play an important role in shaping their companies' preparation for the energy transition by championing particular initiatives. It's hard to imagine that CNOOC would have invested in renewables in the 2000s without Fu Chengyu, equipped with his international experience, as the chairman. Similarly, former Sinopec Group chairman Zhang Yuzhuo's resume reads as if he had been preparing over the course of his entire career to lead Sinopec Group as the company seeks to advance China's hydrogen and CCUS technologies.

Third, external actors can shape the transition activities of China's NOCs, within limits. Indeed, some of the initial steps taken by the NOCs to explicitly prepare for a lower-carbon future resulted from exposure to and collaboration with foreign companies. CNOOC's decision to invest in renewables in the mid-2000s, PetroChina's establishment of what may have been China's first corporate carbon emissions trading team, and Sinopec Corp.'s disclosure of more information about its climate change strategy and risk mitigation measures all grew out of the companies' participation in international markets.

That said, domestic forces play a much more important role in determining the energy transition activities of China's NOCs. The 30-60 goals are a case in point. Xi's announcement of these targets has resulted in a big uptick in what China's NOCs are saying and doing about climate change.



APPENDIX: SOURCES FOR FIGURES AND TABLES

Sources for Figures 1–8

Figure 1: Combined Scope 1 and Scope 2 emissions of select oil companies in 2020

Sinopec Corp., *2020 Sustainability Report*, 83, <http://www.sinopecgroup.com/group/en/Resource/Pdf/SustainReport2020en.pdf>.

PetroChina, *2020 Environmental, Social and Governance Report*, 73, <http://www.petrochina.com.cn/petrochina/xhtml/images/shyhj/2020kcxfbgen.pdf>.

ExxonMobil, *2021 Energy & Carbon Summary*, 38, <https://corporate.exxonmobil.com/-/media/Global/Files/energy-and-carbon-summary/Energy-and-Carbon-Summary.pdf?la=en&hash=9C9C45F0660AEB09B71D140B200C565B40D46872>.

Shell, *Sustainability Report 2020*, 91, <https://reports.shell.com/sustainability-report/2020/servicepages/download-centre.html>.

Saudi Aramco, *Annual Report 2020*, 76, <https://www.aramco.com/-/media/publications/corporate-reports/saudi-aramco-ara-2020-english.pdf>.

Chevron, *2020 Corporate Sustainability Report*, 50–51, <https://www.chevron.com/-/media/shared-media/documents/chevron-sustainability-report-2020.pdf>.

Petrobras, *2020 Sustainability Report*, 21, <https://sustentabilidade.petrobras.com.br/en/src/assets/pdf/Sustainability-Report-2020-Petrobras.pdf>.

BP, *Annual Report and Form 20-F 2020*, 49, <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/investors/bp-annual-report-and-form-20f-2020.pdf>.

ENI, *ENI for 2020: Carbon Neutrality by 2050*, 48, <https://www.eni.com/assets/documents/eng/just-transition/2020/Eni-for-2020-Carbon-neutrality-by-2050.pdf>.

Total, *Form 20-F 2020*, 132, <https://totalenergies.com/system/files/documents/2021-03/2020-total-form-20-f.pdf>.

Occidental Petroleum, *GHG Emissions Summary 2016–2019*, https://www.oxy.com/Sustainability/overview/SiteAssets/Pages/Social-Responsibility-at-Oxy/Assets/Occidental-GhG%20Emissions%20Summary_2016-2019.pdf.

Repsol, *2020 Integrated Management Report*, 70, https://www.oxy.com/Sustainability/overview/SiteAssets/Pages/Social-Responsibility-at-Oxy/Assets/Occidental-GhG%20Emissions%20Summary_2016-2019.pdf.

Equinor, *Sustainability Report 2020*, 30, <https://www.equinor.com/en/news/20210319-annual-sustainability-reports-2020.html>.



CNOOC Ltd., *2020 Environmental, Social and Governance Report*, 90, <https://www.cnooc ltd.com/attach/0/bbfdd87698b542c38f0870d13e36bcd7.pdf>.

Figure 2: Ownership of China's NOCs

PetroChina, *2020 Form 20-F*, 20, <https://www.sec.gov/Archives/edgar/data/0001108329/000119312521140226/d77520d20f.htm>.

Sinopec Corp., *2020 Form 20-F*, 70, https://www.sec.gov/Archives/edgar/data/0001123658/000110465921052188/tm2039442d3_20f.htm.

CNOOC Ltd., *2020 Form 20-F*, 68, https://www.sec.gov/Archives/edgar/data/0001095595/000095010321005896/dp149282_20f.htm.

Figure 3: China's oil and natural gas output in 2020

"China's Crude Oil Production, 2015–2020" (2015–2020年中国原油产量; 2015–2020 nian Zhongguo yuanyou chanliang), *International Petroleum Economics* (国际石油经济; Guoji shiyou jingji) 29, no. 4 (2021): 105, China Academic Journals.

"China's Natural Gas Production, 2015–2020" (2015–2020年中国天然气产量; 2015–2020 nian Zhongguo tianranqi chanliang), *International Petroleum Economics* (国际石油经济; Guoji shiyou jingji) 29, no. 4 (2021): 106, China Academic Journals.

Figure 4: China's refining capacity in 2019

"The Current Market Situation and Competitive Landscape of the Refining Industry in 2019, the Industry's Profitability Is Weak" (2019年炼油行业市场现状及竞争格局, 行业盈利能力较弱; 2019 nian lianyou hangye shichang xianzhuang yu zhenggeju, hangye yinglinengli jiao ruo), *Snowball Finance* (雪球, Xueqiu), October 9, 2020, <https://xueqiu.com/1973934190/160574720>.

Figure 5: World's largest publicly traded oil and gas producers by volume in 2020

Saudi Aramco, *Annual Report 2020*, 24, <https://www.aramco.com/-/media/publications/corporate-reports/saudi-aramco-ara-2020-english.pdf>.

Rosneft, *Annual Report 2020*, 10, https://www.rosneft.com/upload/site2/document_file/a_report_2020_eng.pdf.

PetroChina, *2020 Annual Report*, 19, <http://www.petrochina.com.cn/ptr/ndbg/202104/eafc059543d2429ab3ad454d519cde56/files/a1e7963d63a9429d8226c56c19928dc8.pdf>.

ExxonMobil, *2020 Annual Report*, XIII, <https://corporate.exxonmobil.com/-/media/Global/Files/investor-relations/annual-meeting-materials/annual-report-summaries/2020-Annual-Report.pdf>.

Shell, *Strategic Report 2020*, 42, <https://reports.shell.com/annual-report/2020/servicepages/downloads/files/strategic-report-shell-ar20.pdf>.



Figure 6: World's largest publicly traded refining companies by capacity in 2020

Sinopec Corp., 2020 Form 20-F, 25, https://www.sec.gov/Archives/edgar/data/0001123658/000110465921052188/tm2039442d3_20f.htm.

ExxonMobil, 2020 Form 10-K, 24, <https://www.sec.gov/ix?doc=/Archives/edgar/data/34088/000003408821000012/xom-20201231.htm>.

PetroChina, 2020 Form 20-F, 88, <https://www.sec.gov/Archives/edgar/data/0001108329/000119312521140226/d77520d20f.htm>.

Saudi Aramco, Annual Report 2020, 62, <https://www.aramco.com/-/media/publications/corporate-reports/saudi-aramco-ara-2020-english.pdf>.

Valero, 2020 Summary Annual Report, 10, https://s23.q4cdn.com/587626645/files/doc_financials/2021/ar/2020-Summary-Annual-Report.pdf.

Figure 7: Employees of select oil in 2020

PetroChina, 2020 Form 20-F, 88, <https://www.sec.gov/Archives/edgar/data/0001108329/000119312521140226/d77520d20f.htm>.

Sinopec Corp., 2020 Form 20-F, 69, https://www.sec.gov/Archives/edgar/data/0001123658/000110465921052188/tm2039442d3_20f.htm.

Total, 2020 Form 20-F, 60, <https://www.sec.gov/ix?doc=/Archives/edgar/data/0000879764/000110465921044245/tot-20201231x20f.htm>.

Shell, 2020 Form 20-F, <https://www.sec.gov/ix?doc=/Archives/edgar/data/0001306965/000130696521000025/rdsa-20201231.htm>.

ExxonMobil, 2020 Form 10-K, 1, <https://www.sec.gov/ix?doc=/Archives/edgar/data/34088/000003408821000012/xom-20201231.htm>.

Saudi Aramco, Annual Report 2020, 84, <https://www.aramco.com/-/media/publications/corporate-reports/saudi-aramco-ara-2020-english.pdf>.

BP, Annual Report and Form 20-F 2020, 57, <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/investors/bp-annual-report-and-form-20f-2020.pdf>.

Petrobras, 2020 Form 20-F, 220, https://www.sec.gov/Archives/edgar/data/0001119639/000129281421001152/pbraform20f_2020.htm.

Chevron, 2020 Form 10-K, 4, <https://www.sec.gov/ix?doc=/Archives/edgar/data/0000093410/000009341021000009/cvx-20201231.htm>.

ENI, 2020 Form 20-F, 4, https://www.sec.gov/Archives/edgar/data/1002242/000110465921046015/tm215953-3_20f.htm.

Repsol, Annual Financial Report 2020, 76, <https://www.repsol.com/imagenes/global/en/>



[ori18022021-2020-consolidated-annual-financial-report_tcm14-208557.pdf](#).

Equinor, *2020 Annual Report on Form 20-F*, 139, <https://www.sec.gov/Archives/edgar/data/001140625/000114062521000006/eqnr20f20.htm>.

CNOOC Ltd., *2020 Form 20-F*, 68, https://www.sec.gov/Archives/edgar/data/0001095595/00095010321005896/dp149282_20f.htm.

Occidental Petroleum, *2020 Form 10-K*, 2, <https://www.sec.gov/ix?doc=/Archives/edgar/data/0000797468/000079746821000009/oxy-20201231.htm>.

Figure 8: China's oil production

"China's Crude Oil Production, 2014–2019" (2014–2019年中国原油产量; 2014–2019 nian Zhongguo yuanyou chanliang), *International Petroleum Economics* (国际石油经济; Guoji shiyou jingji) 28, no. 4 (2020): 103, China Academic Journals.

"China's Crude Oil Production, 2015–2020" (2015–2020年中国原油产量; 2015–2020 nian Zhongguo yuanyou chanliang), *International Petroleum Economics* (国际石油经济; Guoji shiyou jingji) 29, no. 4 (2021): 105, China Academic Journals.

Sources for Tables 1–8

Table 1: Overseas oil and natural gas production of China's NOCs in 2020

CNPC, *2020 Annual Report* (2020年度报告; 2020 niandu baogao), 6, <https://www.cnpc.com.cn/cnpc/ndbg/202104/4733d8af74c24a938b50607f75862ee6/files/d1faf5e2e6aa4d9aa479bf9c4c8f346a.pdf>.

PetroChina, *2020 Annual Report*, 19, <http://www.petrochina.com.cn/ptr/ndbg/202104/eafc059543d2429ab3ad454d519cde56/files/a1e7963d63a9429d8226c56c19928dc8.pdf>.

Sinopec Group, *2020 Annual Report* (2020年报; 2020 nianbao), 24, <http://www.sinopecgroup.com/group/Resource/Pdf/GroupAnnualReport2020.pdf>.

Sinopec Corp., *2020 Form 20-F*, 27, https://www.sec.gov/Archives/edgar/data/0001123658/000110465921052188/tm2039442d3_20f.htm.

CNOOC, *2020 Annual Report* (2020年度报告; 2020 niandu baogao), 38, <https://www.cnooc.com.cn/attach/0/2106111016114743.pdf>.

CNOOC Ltd., *2020 Annual Report*, 3, <https://www.cnoocLtd.com/attach/0/c63efe2e72b84001bf234fcc38d836ff.pdf>.

Table 2: Greenhouse gas emissions of China's NOCs

CNOOC Ltd., *2020 Environmental, Social and Governance Report*, 90, <https://www.cnoocLtd.com/attach/0/bbfdd87698b542c38f0870d13e36bcd7.pdf>.



CNOOC Ltd., *2019 Environmental, Social and Governance Report*, 92, <https://www.cnooltd.com/attach/0/1f327d785d4b4fb4bb704eda72ae190a.pdf>.

CNOOC Ltd., *2018 Environmental, Social and Governance Report*, 80, <https://www.cnooltd.com/attach/0/828e24614a4e44abac7c4cad98a1d7e9.pdf>.

PetroChina, *2020 Environmental, Social and Governance Report*, 73, <http://www.petrochina.com.cn/petrochina/xhtml/images/shyhj/2020kcxfzbgen.pdf>.

Sinopec Corp., *2020 Sustainability Report*, 34, <http://www.sinopec.com/listco/en/Resource/Pdf/20210328011.pdf>.

Sinopec Corp., *2019 Communication on Progress for Sustainable Development*, 79, <http://www.sinopec.com/listco/en/Resource/Pdf/2020032945.pdf>.

Table 3: Energy efficiency data for CNOOC Ltd. and PetroChina (kilograms of standard coal consumption per ton of oil and natural gas production)

CNOOC Ltd., *2020 Environmental, Social and Governance Report*, 90, <https://www.cnooltd.com/attach/0/bbfdd87698b542c38f0870d13e36bcd7.pdf>.

CNOOC Ltd., *2018 Environmental, Social and Governance Report*, 47–48, <https://www.cnooltd.com/attach/0/828e24614a4e44abac7c4cad98a1d7e9.pdf>.

PetroChina, *2020 Environmental, Social and Governance Report*, 73, <http://www.petrochina.com.cn/petrochina/xhtml/images/shyhj/2020kcxfzbgen.pdf>.

PetroChina, *2017 Sustainability Report*, 77, <http://www.petrochina.com.cn/petrochina/xhtml/images/shyhj/2017kcxfzbgen.pdf>.

Table 4: Sinopec's energy efficiency data

Sinopec Corp., *2020 Sustainability Report*, 84, <http://www.sinopec.com/listco/en/Resource/Pdf/20210328011.pdf>.

Sinopec Corp., *Communication on Sustainable Development 2017*, 57, <http://www.sinopec.com/listco/en/Resource/Pdf/20180325016.pdf>.

Table 5: Natural gas production Targets targets of China's NOCs for 2025

Thomson Reuters StreetEvents, "Edited Transcript of CNOOC Ltd. Earnings Conference Call or Presentation, Wednesday, August 19, 2020 at 9:00:00am GMT," October 6, 2020, <https://news.yahoo.com/amphtml/edited-transcript-0883-hk-earnings-093622183.html>.

Zheng Xin, "CNPC to Ramp Up Clean Energy Output," *China Daily*, June 11, 2019, <https://www.chinadaily.com.cn/a/201906/11/WS5cff0b99a3101765772307e2.html>.

PetroChina, *2019 Environmental, Social and Governance Report*, 36, <http://www.petrochina.com.cn/ptr/xhtml/images/2019kcxfzbgen.pdf>.



“Can Shale Oil Help the ‘General Battle’ to Increase Oil and Natural Gas Production? (页岩油能否助力油气增产 “大会战” Yeyan you neng fou zhuli youqi zengchan “dahui zhan”), *Caijing Magazine* (财经; Caijing), August 16, 2019, <http://m.caijing.com.cn/api/show?contentid=4610039>.

Sinopec Corp. and China Petroleum & Chemical Corporation, 2019 *Communication on Progress for Sustainable Development*, 38, <http://www.sinopec.com/listco/en/Resource/Pdf/2020032945.pdf>.

Table 6: Carbon peaking targets of select central SOEs

Wang Zhen, “How Should Central Enterprises Deploy Carbon Peaking and Carbon Neutrality? The State-Owned Assets Supervision and Administration Commission Will Study and Formulate Implementation Opinions” (央企该如何部署碳达峰、碳中和? 国资委将专门研究制定实施意见; Yangqi gai ruhe bushu tan da feng, tan zhong he? Guoziwei jiang zhuanmen yanjiu zhiding shishi yijian), *21st Century Business Herald* (21 世纪经济导报; 21 shiji jingji daobao), April 17, 2021, https://m.21jingji.com/article/20210417/herald/03582a90471a448dad1d7e290e52f459_zaker.html.

Han Jiyuan, “The Similarities and Differences of the Carbon Peaking Paths of the Five Major Power Generation Groups” (五大发电集团碳达峰路径的异与同; Wu da fadian jituan tan da feng lujing de yi yu tong), *Energy Research Club* (能源研究俱乐部; nengyuan yanjiu julebu), May 4, 2020, <https://www.in-en.com/article/html/energy-2303936.shtml>.

“China’s Top Steelmaker Baowu Group Vows to Achieve Carbon Neutrality by 2050,” Reuters, January 20, 2021, <https://www.reuters.com/article/us-china-climatechange-baowu/chinas-top-steelmaker-baowu-group-vows-to-achieve-carbon-neutrality-by-2050-idUSKBN29QOG1>.

Zhou Gang, “Datang Group 2021 Work Conference: Achieve ‘Carbon Peak’ 5 Years Ahead of Schedule” (大唐集团2021年工作会议: 提前5年实现 “碳达峰”; Datang jituan 2021 gongzuo huiyi: tiqian 5 nian shixian “tan da feng”), *大唐集团* (Datang Jituan), January 22, 2021, <https://www.china5e.com/news/news-1108650-1.html>.

“Huadian Group Announced a Timetable for Peaking Carbon, Reaching the Peak in 2025, and Striving to Increase the Share of Clean Energy to 50%” (华电集团宣布碳达峰时间表, 2025年达峰, 清洁能源占比力争达到50%; Huadian jituan xuanbu tan da feng shijianbiao, 2025 nian da feng, qingjie nengyuan zha nbi lizheng dadao 50%), *Eknewer* (能见; Nengjian), January 29, 2021, <https://www.163.com/dy/article/G1HOM0EP0511E624.html>.

“The First Energy Central Enterprise to Announce a ‘Carbon Neutrality’ Timetable! Three Gorges Group Plans to Achieve Carbon Neutrality by 2040” (首家宣布 “碳中和” 时间表的能源央企! 三峡集团计划2040年实现碳中和; Shou jia xuanbu “tan zhong he” shijiang biao de nengyuan yangqi! Sanxia jituan jihua 2040 nian shixian tan zhong he), *China Energy Information Platform* (国家能源信息平台; Guojia nengyuan xinxi pingtai), March 15, 2021, <https://baijiahao.baidu.com/s?id=1694310829096922545&wfr=spider&for=pc>.

“The Net Profit of the New Energy Business Surged by 43.8%, China Resources Power Net Profits Were HK\$7.583 Billion Last Year” (新能源业务净利润劲增43.8%, 华润电力去年净赚75.83亿港元; Xin nengyuan yewu lirun jin zeng 43.8%, Huarun dianli qunian zheng jing zhuan 75.83



yi Gang yuan), China Resources WeChat Channel, March 18, 2021, <https://mp.weixin.qq.com/s/vjkdsMsRX7TRJ9GBKnibgg>.

Chen Aizhu, “PetroChina Expects Its Carbon Emissions to Peak around 2025,” Reuters, March 25, 2021, <https://www.reuters.com/article/us-petrochina-results/petrochina-expects-its-carbon-emissions-to-peak-around-2025-idUSKBN2BH1D4>.

Eric Ng, “Chinese Energy Giant Sinopec Bets Future on Hydrogen as It Looks to Reach Decarbonisation Goals Ahead of Time,” *South China Morning Post*, March 29, 2021, <https://sg.news.yahoo.com/chinese-energy-giant-sinopec-bets-054301643.html>.

Lucy Tang, “Chinalco Targets Reaching Carbon Emission Peak before 2025,” S&P Global Platts, June 9, 2021, <https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/060921-chinalco-targets-reaching-carbon-emission-peak-before-2025>.

Table 7: CNPC’s projections of China’s oil and natural gas balance through 2025

Meng Ying, “Dual-Carbon Targets Promote the Accelerated Transformation of the Oil and Gas Industry; China Petroleum Institute of Economic Research Released the *2020 Domestic and Foreign Oil and Gas Industry Development Report*” (双碳目标促油气行业加速转型; 中国石油经研院“2020年国内外油气行业发展报告”发布; Shuang tan mubiao cu youqi hangye jiasu zhuanxing; Zhongguo shiyou jing yan yuan “2020 nian guo nei wai youqi hangye fazhan baogao” fabu), Petroleum Business News (石油商报; Shiyou shang bao), April 29, 2021, <http://center.cnpc.com.cn/sysb/system/2021/04/22/030030794.shtml>.

Table 8: The shifting domestic production mixes of China’s NOCs

“China’s Crude Oil Production, 2015–2020” (2015–2020年中国原油产量; 2015–2020 nian Zhongguo yuanyou chanliang), *International Petroleum Economics* (国际石油经济; Guoji shiyou jingji) 29, no. 4 (2021): 105, China Academic Journals.

“China’s Natural Gas Production, 2015–2020” (2015–2020年中国天然气产量; 2015–2020 nian Zhongguo tianranqi chanliang), *International Petroleum Economics* (国际石油经济; Guoji shiyou jingji) 29, no. 4 (2021): 106, China Academic Journals.



NOTES

1. Ministry of Foreign Affairs of the People's Republic of China, "Xi Jinping Delivers an Important Speech at the General Debate of the 75th Session of the General Assembly of the United Nations," September 22, 2020, https://www.fmprc.gov.cn/mfa_eng/zxxx_662805/t1817766.shtml; and National Development and Reform Commission, "Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions," June 30, 2015, 22, <https://www4.unfccc.int/sites/ndcstaging/Pages/Home.aspx>.
2. Motley Fool Transcribers, "PetroChina Company Limited (PTR) Q3 2020 Earnings Call Transcript," October 30, 2020, <https://www.fool.com/earnings/call-transcripts/2020/10/30/petrochina-company-limited-ptr-q3-2020-earnings-ca/>.
3. Sinopec Corp., *2019 Communication on Sustainable Development*, 18, <http://www.sinopec.com/listco/en/Resource/Pdf/2020032945.pdf>.
4. CNOOC Ltd., *2019 Environmental, Social and Governance Report*, 48, <https://www.cnooltd.com/attach/0/1f327d785d4b4fb4bb704eda72ae190a.pdf>. CNOOC Ltd. has not published the volume of its greenhouse gas emissions in 2015. As a result, the targeted percentage decrease in the company's GHG emissions between 2015 and 2020 cannot be calculated.
5. Chen Aizhu, "PetroChina Expects Its Carbon Emissions to Peak around 2025," Reuters, March 25, 2021, <https://www.reuters.com/article/us-petrochina-results/petrochina-expects-its-carbon-emissions-to-peak-around-2025-idUSKBN2BH1D4>; and Eric Ng, "Chinese Energy Giant Sinopec Bets Future on Hydrogen as It Looks to Reach Decarbonisation Goals Ahead of Time," *South China Morning Post*, March 29, 2021, <https://sg.news.yahoo.com/chinese-energy-giant-sinopec-bets-054301643.html>.
6. Chen Aizhu, "UPDATE 2-Sinopec for Carbon Neutrality by 2050, Plans Pivot to Hydrogen," Reuters, <https://www.reuters.com/article/sinopec-carbon-idCNL1N2LR04C>.
7. CNOOC Ltd., *2020 Environmental, Social and Governance Report*, 60, <https://www.cnooltd.com/attach/0/bbfdd87698b542c38f0870d13e36bcd7.pdf>.
8. CNOOC Ltd., "Environmental Protection – Response to Climate Change," <https://www.cnooltd.com/col/col46301/index.html>.
9. Eric Ng, "Chinese Offshore Oil Giant CNOOC Sets Renewable Energy Goal to Aid Nation's Decarbonisation Efforts," *South China Morning Post*, August 20, 2021, <https://www.scmp.com/business/companies/article/3145693/chinese-offshore-oil-giant-cnooc-sets-renewable-energy-goal-aid>.
10. "Sinopec to Launch First Green Hydrogen Project in 2022," Reuters, May 25, 2021, <https://www.reuters.com/business/sustainable-business/sinopec-launch-first-green-hydrogen-project-2022-2021-05-25/>.



11. “Ma Yongsheng, Member of the National Committee of the Chinese People’s Political Consultative Conference: Accelerate the Construction of a Clean, Low-Carbon, Safe, and Efficient Energy System” (全国政协委员马永生: 加快构建清洁低碳、安全高效的能源体系; Quanguo zhengxie weiyuan Ma Yongsheng: jiakuai goujian qingjie di tan, anquan gaoxiao de nengyuan tixi), Xinhua Finance (新华 财经; Xinhua Caijing), March 7, 2021, <http://news.xinhua08.com/a/20210307/1977913.shtml>.
12. “Outline for the 14th Five-Year Plan for the National Economic and Social Development of the People’s Republic of China and Long-Term Goals for 2035” (中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要; Zhonghua renmin gongheguo guomin jingji he shehui fazhan di shisi ge wu nian guihua he 2035 nian yuanjing mubiao gangyao), March 13, 2021, http://www.gov.cn/xinwen/2021-03/13/content_5592681.htm.
13. Meng Ying, “Dual Carbon Targets Promote Accelerating the Transformation of the Oil and Gas Industry; CNPC’s Economic and Technology Research Report Released the 2020 Domestic and Foreign Oil and Gas Industry Development Report” (双碳目标促油气行业加速转型; 中国石油经研院 “2020年国内外油气行业发展报告发布”; Shuang tan mubiao cu youqi hangye zhuanxing; Zhong shiyou jing yan yuan “2020 nian nei wai youqi hangye baogao fabu), *Petroleum Business News* (石油商报; Shiyou shangbao), April 29, 2021, <http://center.cnpc.com.cn/sysb/system/2021/04/22/030030794.shtml>.
14. See, for example, State-owned Assets Supervision and Administration Commission of the State Council, “A Meeting of the Heads of Central Enterprises Was Held in Beijing” (中央企业负责人会议在京召开; Zhongyang qiye fuzeren huiyi zai jing huiyi), December 25, 2020, <http://www.sasac.gov.cn/n2588025/n2643314/c16316697/content.html>.
15. I thank Jon Elkind for this point.
16. State-owned Assets Supervision and Administration Commission of the State Council, “What We Do,” <http://en.sasac.gov.cn/index.html>; and State-owned Assets Supervision and Administration Commission of the State Council, “Central Enterprise Directory” (央企名录; yangqi minglu), June 5, 2020, <http://www.sasac.gov.cn/n2588035/n2641579/n2641645/c4451749/content.html>.
17. “How Beijing Governs SOEs,” Plenum China, January 13, 2020, 1, <https://plenum.ai/>, and email from an expert on central SOEs, April 9, 2020.
18. “How Beijing Governs SOEs,” January 13, 2020.
19. Richard McGregor, *The Party: The Secret World of China’s Communist Rulers* (New York: Harper, 2010), chapter 3.
20. PetroChina, “About PetroChina—Executive Profiles,” <http://www.petrochina.com.cn/ptr/ldjs/202003/bc4b3a7ce181416591ccbdbe63492a47.shtml>, and CNOOC Ltd., “Senior Management,” <https://www.cnooc.com.cn/col/col6201/index.html>.
21. Sinopec Corp., *2019 Annual Report and Accounts*, 60, <http://www.sinopecgroup.com/group/en/Resource/pdf/2020042310.pdf>; Fu Rong, “Zhang Yuzhuo’s Promotion from



Sinopec Chairman to Party Secretary of the China Association for Science and Technology Shows a Carbon Neutral Roadmap for Petrochemical Companies” (从中石化董事长张玉卓升任中国科协党组书记 看石化企业碳中和之路; Cong Zhongshihua dongshizhang Zhang Yuzhuo sheng ren Zhongguo kexie dangzu shuji kan shihua qiye zhong zhi lu), Eknower (能见; Nengjian), August 3, 2021, <https://news.bjx.com.cn/html/20210803/1167410.shtml>; and Trivium China, “Tip Sheet,” August 10, 2021, <https://triviumchina.com/2021/08/10/far-from-a-done-deal/>.

22. PetroChina is listed on all three stock exchanges, Sinopec is listed in Hong Kong and New York, and CNOOC Ltd. is only listed in Hong Kong following the New York Stock Exchange’s delisting of the company under an executive order signed by President Donald Trump in November 2020. See “CNOOC Faces NYSE Delisting of American Depositary Shares,” Bloomberg, February 26, 2021, <https://www.bloomberg.com/news/articles/2021-02-26/china-s-cnooc-faces-nyse-delisting-of-american-depositary-shares>.
23. Federated Hermes International, *EOS Engagement Plan 2021-2023*, February 1, 2021, <https://www.hermes-investment.com/us/eos-insight/eos/eos-engagement-plan-2021-2023/>; and Savvy Investor, “Climate Change and Institutional Investors,” June 18, 2020, 22, <https://www.savvyinvestor.net/blog/climate-change-institutional-investors>.
24. DBS Bank, “Regional Energy: China Refining & Petrochemical,” March 3, 2020, 21, https://www.dbs.id/id/corporate-id/aics/pdfController.page?pdfpath=/content/article/pdf/AIO/032020/200303_insights_reg_energy.pdf, and “China Oil Refining Profits Plunge 42% in 2019 as Overcapacity Grows,” Reuters, March 3, 2020, <https://www.reuters.com/article/china-crude-profits/china-oil-refining-profits-plunge-42-in-2019-as-overcapacity-grows-industry-idUSL4N2AW107>.
25. Interview with Beijing-based industry expert, February 24, 2020.
26. PetroChina, *2018 Environmental, Social and Governance Report*, 20, <http://www.petrochina.com.cn/ptr/xhtml/images/2018kcxzbgen.pdf>.
27. Greenhouse Gas Protocol, “About Us,” <https://ghgprotocol.org/about-us>, and Greenhouse Gas Protocol, *Corporate Value Chain (Scope 3) Accounting and Reporting*, April 16, 2013, 5, https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporting-Standard_041613_2.pdf.
28. Neil Beveridge, Brian Ho, and Jenny Ku, “Asia-Pac Oil Majors and E&Ps: How Do APAC Companies Score on ESG and Which Ones Are the Best?” Bernstein Asia-Pacific Oil & Gas, January 16, 2020, 5.
29. Sinopec Corp., *2020 Sustainability Report*, 34, <http://www.sinopec.com/listco/en/Resource/Pdf/20210328011.pdf>.
30. Beveridge, Ho, and Ku, “Asia-Pac Oil Majors and E&Ps,” January 16, 2020, 5.
31. Simon Dietz et al., “Carbon Performance in Oil and Gas: Discussion Paper,” November 2018, 10, <https://www.transitionpathwayinitiative.org/publications/27.pdf?type=Publication>.



32. Email from David Fridley, March 24, 2020.
33. Motley Fool Transcribers, "PetroChina Company Limited," October 30, 2020.
34. Thomson Reuters StreetEvents, "Edited Transcript of CNOOC Ltd. Earnings Conference Call or Presentation, Wednesday, August 19, 2020 at 9:00:00am GMT," October 6, 2020, <https://news.yahoo.com/amphhtml/edited-transcript-0883-hk-earnings-093622183.html>.
35. "Lü Dapeng: Sinopec Actively Explores Green Energy" (吕大鹏: 中国石化积极探索绿色能源; Lü Dapeng: Zhong Shihua jiji tansuo lüse nengyuan), Xinhua Online (新华网; Xinhua wang), September 14, 2018, http://www.xinhuanet.com/energy/2018-09/14/c_1123432112.htm.
36. "China's Coal Share of Energy Consumption Falls in 2020, But Overall Coal Use Up," *South China Morning Post*, February 28, 2021, <https://www.scmp.com/economy/china-economy/article/3123464/chinas-coal-share-energy-consumption-falls-2020-overall-coal>; International Energy Agency, *The Role of Gas in Today's Energy Transitions*, 2019, 4, <https://www.iea.org/reports/the-role-of-gas-in-todays-energy-transitions>; and Yu Qin, Ryan Edwards, Fan Tong, and Denise L. Mauzerall, "Can Switching from Coal to Shale Gas Bring Net Carbon Reductions?" *Environmental Science & Technology*, no. 51 (2017), <https://cedmcenter.org/wp-content/uploads/2017/10/Can-Switching-from-Coal-to-Shale-Gas-Bring-Net-Carbon-Reductions-to-China.pdf>.
37. International Energy Agency, *The Role of Gas*, 4.
38. Alejandra Borunda, "Natural Gas Is a Much 'Dirtier' Energy Source Than We Thought," *National Geographic*, February 19, 2020, <https://www.nationalgeographic.com/science/article/super-potent-methane-in-atmosphere-oil-gas-drilling-ice-cores>.
39. Ibid. and David Sandalow, *Guide to Chinese Climate Policy 2019*, Center on Global Energy Policy, School of International and Public Affairs, Columbia University, 47, <https://www.energypolicy.columbia.edu/research/report/2019-guide-chinese-climate-policy>.
40. I thank Robert Kleinberg for a helpful discussion of the issues addressed in this paragraph.
41. PetroChina, *2018 Environmental, Social, and Governance Report*, 22; CNPC, 2019 Environmental Protection Report (2019 环境保护公报; 2019 huanjing baohu gongbao), 26, <http://www.cnpc.com.cn/cnpc/lncbw/202006/d86bb24fe0f0450aa9145f6b1bbe3e59/files/667b7211650b469f833e880952b7916c.pdf>; Sinopec Corp., *Communication on Sustainable Development 2019*, 35; and Chen Yiran and Jiang Haifeng, "CNOOC Launches Greenhouse Gas Emission Inventory Project" (中海油的温室气体盘查; Zhonghaiyou de wenshi qiti pancha), *Carbon Market* (碳市场; tan shichang), October 2013, <http://images.bjets.com.cn/www/201312/tsc2013autumn.pdf>.
42. PetroChina, *2019 Environmental, Social, and Governance Report*, 32, <http://www.petrochina.com.cn/ptr/xhtml/images/2019kcxzfzbgcn.pdf>; Sinopec Corp., *2019 Communication on Sustainable Development 2019*, 35; and Lu Di, "Construction and Implementation of CNOOC's Green Supply Chain," *China Oil & Gas*, no. 3 (2018), <http://www.coag.com.cn/CN/article/downloadArticleFile.do?attachType=PDF&id=3735>.



43. PetroChina, *2019 Environmental, Social, and Governance Report*, 57; CNPC, 2019 Environmental Protection Report, 26; and Sinopec Corp., *2019 Communication on Sustainable Development*, 35.
44. CNPC, *2019 Environmental Protection Report*, 26, and Oil and Gas Climate Initiative, “CNPC: Tackling Methane Emissions,” <https://oilandgasclimateinitiative.com/knowledge-base/cnpc-case-study/>.
45. “China’s CNPC Targets 50% Slash in Methane Emission Intensity by 2025,” Reuters, July 2, 2020, <https://www.reuters.com/article/us-china-cnpc-carbon/chinas-cnpc-targets-50-slash-in-methane-emission-intensity-by-2025-idUSKBN2430P7>.
46. Federated Hermes International, “EOS Insight—Sinopec,” November 1, 2018, <https://www.hermes-investment.com/us/eos-insight/eos/sinopec/>.
47. See the comments of former CNOOC Ltd. Chairman Yuan Guanyu in “The New Energy Strategies of the ‘Three Barrels of Oil’: Starting with CNOOC’s Return to Offshore Wind Power after Seven Years” (“三桶油” 的新能源战略: 从中海油时隔7年重回海上风电谈起; “San tong you” de xin nengyuan zhanlue: cong Zhongshiyou de shige 7 nian chong hui haishan fengdian tanqi), Sohu (搜狐; Souhu), July 17, 2019, https://www.sohu.com/a/327435024_257552?spm=smcpc.content.share.1.1563321600023oXoZw5N.
48. Telephone interview with Joanna Lewis, January 22, 2020.
49. CNOOC Ltd., *Annual Report 2007*, 62, [https://www.worldreginfo.com/wdoc.aspx%3Ffile%3DCNOOC_\(Red_Chip\)/2/33F42235-14C2-445E-BBC4-F074E83CF6E8/104002_cnooc_annual_report\(2007\).pdf+&cd=1&hl=en&ct=clnk&gl=us](https://www.worldreginfo.com/wdoc.aspx%3Ffile%3DCNOOC_(Red_Chip)/2/33F42235-14C2-445E-BBC4-F074E83CF6E8/104002_cnooc_annual_report(2007).pdf+&cd=1&hl=en&ct=clnk&gl=us).
50. CNOOC Ltd., “2019 Strategy Preview,” January 23, 2019, 24, <https://www.cnoocltd.com/attach/O/f0663ec0acb542378743de74ded16582.pdf>; and “CNOOC Limited Announces the First Offshore Wind Power Project Connects to Grid,” PRNewswire, September 15, 2020, <https://www.prnewswire.com/news-releases/cnooc-limited-announces-the-first-offshore-wind-power-project-connects-to-grid-301130992.html>.
51. CNOOC Ltd., *Annual Report 2019*, 14, <https://www.cnoocltd.com/attach/O/f6a7aa6b93294582889a1b0aec07c8f1.pdf>.
52. Chen Aizhu, “Chinese Oil Major CNOOC to Lift Investment to Highest Since 2014,” Reuters, January 13, 2020, <https://www.reuters.com/article/us-china-cnooc/chinese-oil-major-cnooc-to-lift-investment-to-highest-since-2014-idUSKBN1ZC12Q>.
53. Oceana Zhou, “CNOOC Plans to Raise Oil, Gas Output 4% on Year to About 1.5 Million boe/d in 2021,” Platts, February 5, 2021, <https://www.spglobal.com/platts/en/market-insights/latest-news/natural-gas/020521-cnooc-plans-to-raise-oil-gas-output-4-on-year-to-about-15-mil-boed-in-2021>.
54. Chen Aizhu, “Sinopec Aims for Carbon Neutrality by 2050, Plans Pivot to Hydrogen,” Reuters, March 29, 2021, <https://www.reuters.com/world/china/sinopec-aims-carbon->



- [neutrality-by-2025-with-pivot-hydrogen-2021-03-29/](#); and Oceana Zhou and Cindy Liang, “Sinopec to Leverage Hydrogen to Meet Carbon Neutrality by 2020,” *Platts Oilgram News*, March 30, 2021, Factiva.
55. Zhou and Liang, “Sinopec to Leverage Hydrogen,” March 30, 2021.
 56. Chen Aizhu and Muyu Xu, “RPT-Factbox: China’s National Oil Companies Outline Early Green Energy Plans,” Reuters, September 3, 2020, <https://www.reuters.com/article/china-oil-lowercarbon/rpt-factbox-chinas-national-oil-companies-outline-early-green-energy-plans-idUSL4N2G02P3>.
 57. Zhou and Liang, “Sinopec to Leverage Hydrogen,” March 30, 2021; and Maryelle Demongeot, “China’s Sinopec Sets Long-Term Carbon Goals,” *International Oil Daily*, March 29, 2021, Factiva.
 58. World Energy Council, “New Hydrogen Economy—Hype or Hope?” Innovation Insights Brief 2019, 5, <https://www.worldenergy.org/assets/downloads/WEInsights-Brief-New-Hydrogen-economy-Hype-or-Hope-ExecSum.pdf>.
 59. Tom Di Christopher, “Experts Explain Why Green Hydrogen Costs Have Fallen and Will Keep Falling,” *S&P Global Market Intelligence*, March 5, 2021, <https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/experts-explain-why-green-hydrogen-costs-have-fallen-and-will-keep-falling-63037203>.
 60. “Sinopec Puts Forward a New Vision: To Build a World Leading Clean Energy and Chemical Company” (中国石化提出新愿景：打造世界领先洁净能源化工公司; Zhongguo shihua tichu xin yuanjing: dazao shijie lingxian jiejing nengyuan huagong gongsi), Xinhua (新华; Xinhua), July 21, 2020, http://www.xinhuanet.com/energy/2020-07/21/c_1126265564.htm.
 61. “Zhang Yuzhuo: Sinopec Will Continue to Increase Investment in the Field of Hydrogen Energy” (张玉卓：中国石化将继续加大氢能领域投资力度; Zhang Yuzhuo: Zhongguo shihua jiang jixu jia da qingneng lingyu touzi lidu), Xinhua (新华; Xinhua), July 24, 2020, http://www.xinhuanet.com/energy/2020-07/24/c_1126279810.htm.
 62. Zheng Xin, “Pioneering Fuel Station Built in Guangdong,” *China Daily*, July 1, 2019, <http://www.chinadaily.com.cn/a/201907/01/WS5d19cbc2a3103dbf1432b41d.html>; and “Sinopec Builds China’s First Hydrogen Pumping Station,” Reuters, July 1, 2019, <https://uk.reuters.com/article/uk-china-sinopec-fuel-hydrogen/sinopec-builds-chinas-first-hydrogen-pumping-station-idUKKCN1TW1JB>.
 63. Neil Beveridge, Brian Ho, and Jenny Ku, “Sinopec: Building Out the World’s Largest Hydrogen Network,” Alliance Bernstein, March 2, 2021, 5; and Krystal Chia, “Sinopec Throws Itself into Hydrogen for China’s Green Car Goals,” Bloomberg, February 21, 2021, <https://www.bloomberg.com/news/articles/2021-02-22/sinopec-throws-itself-into-hydrogen-for-china-s-green-car-goals>.
 64. Sebastian Lewis, “In Northern China’s Hydrogen Push, By-Product Output and Renewables Lead the Way,” *S&P Global Platts*, July 8, 2020, <https://www.spglobal.com/en/research-insights/articles/in-northern-china-s-hydrogen-push-by-product-output-and-renewables->



[lead-the-way.](#)

65. “PetroChina, Foton, SinoHytec to Jointly Build,” YiCai, April 21, 2020, <https://www.yicaiglobal.com/news/petrochina-foton-sinohytec-to-jointly-build-beijing-hydrogen-stations>.
66. Linde, “Linde Signs MOU with CNOOC to Jointly Develop China’s Hydrogen Energy Industry,” July 23, 2020, <https://www.linde.com/news-media/press-releases/2020/linde-signs-mou-with-cnooc-to-jointly-develop-china-s-hydrogen-energy-industry>.
67. Raimund Malischek, *CCUS in Industry and Transformation*, tracking report, International Energy Agency, June 2020, <https://www.iea.org/reports/ccus-in-industry-and-transformation>; and Alvina Board, “China ‘Setting the Pace’ as It Establishes the World’s 18th Large-Scale CCS Facility,” IEA Clean Coal Centre, August 22, 2018, <https://www.iea-coal.org/china-setting-the-pace-as-it-establishes-worlds-18th-large-scale-ccs-facility/>. The Global CCS Institute defines a large-scale project as a facility that comprises the capture, transport and storage of at least 400,000 tons per year of carbon dioxide for emissions-intensive industrial facilities other than coal-fired power generation. See Global CCS Institute, “Global Facilities Database,” <https://co2re.co/FacilityData#:~:text=%E2%80%8B%E2%80%8B%20Large%2Dscale%20integrated,gas%E2%80%93based%20power%20generation>.
68. Global CCS Institute, “‘Setting the Pace’—China Establishes the World’s 18th Large-Scale CCS Facility,” IEA Clean Coal Centre, August 13, 2018, <https://www.globalccsinstitute.com/news-media/press-room/media-releases/setting-the-pace-china-establishes-worlds-18th-large-scale-ccs-facility/>.
69. Global CCS Institute, *Global Status of CCS 2020*, 70–71, <https://www.globalccsinstitute.com/wp-content/uploads/2021/03/Global-Status-of-CCS-Report-English.pdf>.
70. PetroChina, *2019 Environmental, Social and Governance Report*, 35.
71. Wang Zhen and Xu Lijiao, “Development Status and Prospects of CCS-EOR Technology in China,” *China Oil & Gas*, no. 2 (2018), 26, China Academic Journals.
72. China National Petroleum Corporation, “Industrial CCS-EOR in CNPC’s Jilin Oilfield,” <http://www.cnpc.com.cn/en/xhtml/pdf/2018CCSEORinJilin.pdf>.
73. Ibid.
74. “Enhance Oil Recovery—Do You Have the Right EOR Strategy?” Elsevier, 2016, https://www.elsevier.com/_data/assets/pdf_file/0017/230831/RDS_OG_EP_WP_-EOR-Right-Strategy_DIGITAL.pdf, and John Kemp, “RPT-COLUMN-Could Shale Revive China’s Flagging Oil Fields?” Reuters, August 22, 2014, <https://www.reuters.com/article/china-shale-kemp-idUSL5NOQS1IN20140822>.
75. Oil and Gas Climate Initiative, *Annual Report 2019*, 48, <https://oilandgasclimateinitiative.com/wp-content/uploads/2019/10/OGCI-Annual-Report-2019.pdf>.
76. Oil and Gas Climate Initiative, “Scaling Up Action: Aiming for Net Zero Emissions,” September 2019, 6, 41–49, <https://oilandgasclimateinitiative.com/wp-content/>



[uploads/2019/10/OGCI-Annual-Report-2019.pdf](#).

77. International Energy Agency, *Transforming Industry through CCUS*, May 2019, 27–28, <https://ccsknowledge.com/pub/Publications/2019May IEA Transforming Industry CCUS.pdf>.
78. National Development and Reform Commission, “13th Five-Year Plan,” 11.
79. Ibid. and International Energy Agency, *Transforming Industry*, 28.
80. Malischek, *CCUS in Industry and Transformation*, June 2020.
81. CNPC, “Supporting the Paris Agreement and Promoting Carbon Emission Reduction in the Oil and Gas Industry,” <https://www.cnpc.com.cn/en/environmentcase/201710/e57e6d98a16d4c60994f8974ed211644.shtml>.
82. Oil and Gas Climate Initiative, “OGCI at a Glance—Our Milestones,” <https://oilandgasclimateinitiative.com/ogci-at-a-glance/#milestones>; and Jonathan Elkind, *Toward a Real Green Belt and Road*, April 25, 2019, 8, <https://www.energypolicy.columbia.edu/research/commentary/toward-real-green-belt-and-road>.
83. Oil and Gas Climate Initiative members: <https://www.ogci.com/about-us/who-we-are/>; and Akshat Rathi, “Pemex Is No Longer Active in Oil Industry’s Key Climate Group,” Bloomberg, December 2, 2020, <https://www.bloomberg.com/news/articles/2020-12-02/pemex-is-no-longer-active-in-oil-industry-s-key-climate-group>.
84. Oil and Gas Climate Initiative, “OGCI at a Glance—By the Numbers,” <https://oilandgasclimateinitiative.com/ogci-at-a-glance/>.
85. Oil and Gas Climate Initiative, “Oil and Gas Climate Initiative Sets First Collective Methane Target for Member Companies,” September 24, 2018, <https://oilandgasclimateinitiative.com/oil-and-gas-climate-initiative-sets-first-collective-methane-target-for-member-companies/>.
86. Oil and Gas Climate Initiative, “OGCI Sets Carbon Intensity Target,” July 16, 2020, <https://oilandgasclimateinitiative.com/carbon-intensity-target-pr/>.
87. Oil and Gas Climate Initiative, “At Work: Committed to Climate Action,” September 2018, 16, https://www.ogci.com/wp-content/uploads/2018/09/OGCI_Report_2018.pdf.
88. Oil and Gas Climate Initiative, “At Work,” 18; and Oil and Gas Climate Initiative, “OGCI Climate Investments: Expanding Reach to China with CNPC and Investments Announced,” September 24, 2018, <https://oilandgasclimateinitiative.com/ogci-climate-investments-and-cnpc-enter-into-an-agreement-for-creation-of-new-chinese-technology-investment-fund/>.
89. Carlos Anchondo, “Oil and Gas Companies Announce a New CO₂ Emissions Target,” E&E News, July 17, 2020, <https://www.scientificamerican.com/article/oil-and-gas-companies-announce-a-new-co2-emissions-target/>; and Sandra Laville, “‘Greenwashing’: Fossil Fuel Execs to Hold Invite-Only Forum at UN Climate Summit,” *Guardian*, September 18, 2019, <https://www.theguardian.com/environment/2019/sep/18/fossil-fuel-invite-only-forum-un-climate-summit>.



90. "U.S. Firms Join Oil Industry Climate Group as Pressure Becomes Too Hard to Ignore," *Forbes*, September 28, 2018, <https://www.forbes.com/sites/mikescott/2018/09/28/us-firms-join-oil-industry-climate-group-as-pressure-becomes-too-hard-to-ignore/?sh=3424cd08f1a5>; and Laville, "Greenwashing': Fossil Fuel Execs," September 18, 2019.
91. "U.S. Firms Join Oil," September 28, and Mark Brownstein, "Things OGCi Gets Right," Twitter, July 16, 2020, https://twitter.com/MarkSBrownstein/status/1283689533889019905?utm_source=newsletter&utm_medium=email&utm_campaign=newsletter_axiosgenerate&stream=top.
92. "Equinor Sees Oil Demand Peaking Two-Three Years Sooner Due to Virus," Reuters, November 17, 2020, <https://www.reuters.com/article/us-equinor-oil/equinor-sees-oil-demand-peaking-two-three-years-sooner-due-to-virus-idUSKBN27XOHW>.
93. Rania El Gamal, David Barbuscia, and Marwa Rashad, "Sole Survivor? Saudi Aramco Doubles Down on Oil to Outlast Rivals," Reuters, October 6, 2020, <https://www.reuters.com/article/us-saudi-aramco-strategy-insight-idUSKBN26R3PA>.
94. Equinor, "Equinor Sets Ambition to Reach Net-Zero Emissions by 2050," November 2, 2020, <https://www.equinor.com/en/news/20201102-emissions.html>.
95. Ibid. and Equinor, *Climate Roadmap*, November 2, 2020, 7, <https://www.equinor.com/en/sustainability/climate.html>.
96. Equinor, "Reducing Our Greenhouse Gas Emissions," <https://www.equinor.com/en/sustainability/our-approach/reducing-ghg-emissions.html>.
97. Equinor, "Equinor Sets Ambition," November 2, 2020; and Equinor, *Climate Roadmap*, 7.
98. This paragraph is based on Equinor, "Equinor Sets Ambition to reach net-zero emissions by 2050," November 2, 2020.
99. Equinor, "What We Do: Offshore Wind," <https://www.equinor.com/en/what-we-do/wind.html>.
100. See *Petroleum Intelligence Weekly's* interview with Saudi Aramco CEO Amin Nasser: "Aramco CEO Braces for 'Completely Different' Downturn," *Petroleum Intelligence Weekly*, October 9, 2020, Factiva.
101. Anthony DiPaola, "Aramco Pumps Oil at Fraction of Rivals' Costs and Way More of It," Bloomberg, April 1, 2019, Business Source Direct, and Saudi Arabian Oil Company, Base Prospectus, April 1, 2019, https://www.rns-pdf.londonstockexchange.com/rns/6727U_1-2019-4-1.pdf
102. Saudi Aramco, *Annual Report 2020*, 9, <https://www.aramco.com/-/media/publications/corporate-reports/saudi-aramco-ara-2020-english.pdf>.
103. Saudi Aramco, *Annual Report 2019*, 73, <https://www.aramco.com/-/media/publications/corporate-reports/saudi-aramco-ara-2019-english.pdf>.



104. Saudi Aramco, “Technology Development—Transport Technologies,” <https://www.aramco.com/en/creating-value/technology-development/transport-technologies>.
105. “Saudi Aramco Bets on Exports Ramping Up from 2030,” Bloomberg, June 28, 2021, <https://www.jwnenergy.com/article/2021/6/28/saudi-aramco-bets-on-blue-hydrogen-exports-ramping/>.
106. Katie McQue, “Saudi Aramco Sees Market Gaining Momentum after 2030,” *S&P Global Platts*, February 22, 2021, <https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/022221-saudi-aramco-sees-hydrogen-market-gaining-momentum-after-2030>.
107. National Development and Reform Commission, “12th Five-Year Plan for the Development of Natural Gas” (天然气十二五发展规划; Tianranqi shi'erwu fazhan gui Hua), October 22, 2012, http://www.gov.cn/gongbao/content/2013/content_2326571.htm.
108. National Development and Reform Commission, “13th Five-Year Plan for the Development of Natural Gas” (天然气十三五规划; Tianranqi shisanwu gui Hua), December 24, 2016, http://www.gov.cn/xinwen/2017-01/19/content_5161260.htm.
109. National Development and Reform Commission, “Outline of the 12th Five-Year Plan for the National Economic and Social Development of the People’s Republic of China” (中华人民共和国国民经济和社会发展第十二个五年规划纲要; Zhonghua renmin gongheguo guomin jingji he shehui fazhan di shiyi wu nian gui Hua gangyao), the Central People’s Government of the People’s Republic of China (中华人民共和国中央人民政府; Zhonghua renmin gongheguo), March 16, 2011, http://www.gov.cn/2011lh/content_1825838_2.htm.
110. National Development and Reform Commission, “Notice on Organizing and Carrying Out the Work of Reporting the Greenhouse Gas Emissions of Key Enterprises (Institutions)” (关于组织开展重点企（事）业单位温室气体排放报告工作的通知; Guanyu zuzhi kaizhan zhongdian qi (shi) ye danwei wenshi qiti paifang baogao gongzuo de tongzhi), January 13, 2014, <http://www.cgjnw.org/article.php?id=2157>. See also “China Tells Firms to Start Reporting Carbon Emissions,” Reuters, March 18, 2014, Factiva.
111. “China Moves toward Mandatory Corporate GHG Reporting,” World Resources Institute, 2014, <https://www.wri.org/our-work/top-outcome/china-moves-toward-mandatory-corporate-ghg-reporting>.
112. National Development and Reform Commission, “Notice of the General Office of the National Development and Reform Commission on Issuing the Second Batch of Accounting Methods and Reporting Guidelines for Greenhouse Gas Emissions by Enterprises in 4 Industries (Trial Implementation)” (国家发展改革委办公厅关于印发第二批4个行业企业温室气体排放核算方法与报告指南（试行）的通知; Guojia fazhan gaige wei bangong ting guanyu di er 4 ge hangye qiye wenshi qiti paifang hesuan fangfa yu baozhi nan), December 3, 2014, https://www.ndrc.gov.cn/xxgk/zcfb/tz/201502/t20150209_963759.html.
113. Ibid.



114. National Development and Reform Commission, "Outline of the 12th Five-Year Plan," March 16, 2011.
115. Josh Margolis, Daniel J. Dudek, and Anders Hove, "Carbon Emissions: Rolling Out a Successful Carbon Trading System," Paulson Institute, September 2015, 13, <http://www.paulsoninstitute.org/wp-content/uploads/2015/09/5-Emissions-Trading-EN-final1.pdf>.
116. Da Zhang, Valerie J. Karpus, Cyril Cassisa, and Xiliang Zhang, "Emissions Trading in China: Progress and Prospects," *Energy Policy*, 75 (December 2014): 9–16, https://globalchange.mit.edu/sites/default/files/MITJPSPGC_Reprint_14-22_0.pdf.
117. "In-Depth Q&A: Will China's Emissions Trading Scheme Help Tackle Climate Change?" Carbon Brief, June 24, 2021, <https://www.carbonbrief.org/in-depth-qa-will-chinas-emissions-trading-scheme-help-tackle-climate-change>.
118. Sinopec Group, *2020 Sustainability Report*, 38, <http://www.sinopecgroup.com/group/en/Resource/Pdf/SustainReport2020en.pdf>.
119. Huw Slater, Wang Shu, and Dmitri De Boer, "China's National Carbon Market Is About to Launch," China Dialogue, January 29, 2021, <https://chinadialogue.net/en/climate/chinas-national-carbon-market-is-about-to-launch/>.
120. "China Emissions Prices Surge as ETS Starts Operations," Argus, July 16, 2021, <https://www.argusmedia.com/en/news/2234905-china-emissions-prices-surge-as-ets-starts-operations>.
121. "How Will China's ETS Work?" section of "In-Depth Q&A," June 24, 2021.
122. Bianca Nogrady, "China Launches the World's Largest Carbon Market: But Is It Ambitious Enough?" *Nature*, July 20, 2021, <https://www.nature.com/articles/d41586-021-01989-7>.
123. Christian Shepherd, "China's Carbon Market Scheme Too Limited, Say Analysts," *Financial Times*, July 16, 2021, <https://www.ft.com/content/3bcc2380-8544-4146-ba71-83944caff48d>.
124. Rochelle Toplensky, "Europe's Carbon Prices Are Going Global," *Wall Street Journal*, July 1, 2021, <https://www.wsj.com/articles/europes-carbon-prices-are-going-global-11626269612>.
125. Huw Slater, Dmitri de Boer, Qian Guoqiang, and Wang Shu, "2020 China Carbon Pricing Survey," December 2020, VI, <http://www.chinacarbon.info/wp-content/uploads/2020/12/2020-CCPS-EN.pdf>. I converted the projections using an exchange rate of CNY 6.5 per dollar.
126. Jiang Lin, Nan Zhou, Mark D. Levine, and David Fridley, "Taking Out One Billion Tons of CO₂: The Magic of China's 11th five Five-Year Plan," Ernest Orlando Lawrence Berkeley National Laboratory, June 2007, <https://eta-publications.lbl.gov/sites/default/files/lbl-757e-11th-fypjune-2007.pdf>.
127. Mark D. Levine, Nan Zhou, and Lynn Price, "The Greening of the Middle Kingdom: The Story of Energy Efficiency in China," *Energy Efficiency* 39, no. 1 (June 1, 2009), <https://>



- www.nae.edu/14951/The-Greening-of-the-Middle-Kingdom-The-Story-of-Energy-Efficiency-in-China; and Erica Downs, *China's Rise in Historical Perspective*, ed. Brantly Womack, (Rowman & Littlefield, 2010), 173.
128. Levine, Zhou, and Price, "The Greening of the Middle Kingdom," *Energy Efficiency*.
 129. Ibid.
 130. Ibid.
 131. Valerie J. Karplus, Xingyao Shen, and Da Zhang, "Scaling Compliance with Coverage? Firm-Level Performance in China's Industrial Energy Conservation Program," Tsinghua-MIT China Energy & Climate Project, Report 303, October 2016, <https://core.ac.uk/download/pdf/89360221.pdf>.
 132. Ibid.
 133. "'10,000 Enterprise Energy Saving and Low Carbon Actions' List of Enterprises and Energy Saving Targets" ("万家企业节能低碳行动" 企业名单及节能目标; "Wan jia qiye jieneng ditan xingdong" qiye mingdan ji jieneng liang mubiao), China Electricity Council, <http://www.cec.org.cn/d/file/yaowenkuaidi/2012-05-22/17bae90361404df2a2718f13381ecfdf.pdf>; National Development and Reform Commission, "Appendix 1: Fact Sheet of Energy Saving Target Completion of the 1,000 Enterprises during the 11th Five-Year Plan Period" ("十一五" 期间千家企业节能目标完成情况表; "Shi yi wu" qijian qianjia qiye jieneng mubiao wangcheng qingkuangbiao), December 2011, https://www.ndrc.gov.cn/xxgk/zcfb/gg/201112/W020190_905485001363258.pdf; and D. Zhang, Karpus, Cassisa, and X. Zhang, "Emissions Trading in China," 9-16.
 134. National Development and Reform Commission, "Review of Energy Conservation and Emission Reduction during the '11th Five-Year Plan: The Top-1000 Enterprises Have Exceeded Their Tasks" ("十一五" 节能减排回顾: 千家企业超额完成任务; "shi yi wu" jieneng jian pai huigu: qian jia qiye chao'e wancheng renwu), September 30, 2011, http://www.gov.cn/gzdt/2011-09/30/content_1960586.htm.
 135. Karplus, Shen, and Zhang, "Scaling Compliance with Coverage?," 3.
 136. National Development and Reform Commission, "Appendix 1," December 2011.
 137. National Development and Reform Commission, "Announcement of the National Development and Reform Commission of the People's Republic of China" (中华人民共和国国家发展和改革委员会公告; Zhonghua renmin gonghe guo guojia fazhan he gaige weiyuanhui gonggao), no. 34 (December 30, 2015), https://www.ndrc.gov.cn/xxgk/zcfb/gg/201601/t20160107_961143.html.
 138. Lawrence Berkeley National Laboratory, "Lifetime Achievement Award—Lynn Price," <https://recognition.lbl.gov/2020-laureates/lifetime-achievement-awardee-lynn-price/#:~:text=Building%20on%20international%20comparative%20analysis,rapidly%20expanding%20industry%20in%20China.&text=In%202013%2C%20The%20Economist%20>



[called,climate%20policy%20in%20the%20world.%E2%80%9D.](#)

139. Lisa Williams, "China's Climate Change Policies: Actors and Drivers," Lowy Institute for International Policy, July 2014, 14, <https://www.lowyinstitute.org/publications/chinas-climate-change-policies-actors-and-drivers>.
140. "China to 'Declare War' on Pollution, Premier Says," Reuters, March 4, 2014, <https://www.reuters.com/article/us-china-parliament-pollution/china-to-declare-war-on-pollution-premier-says-idUSBREA2405W20140305>.
141. "Xi Stresses Efforts to Win 'Three Tough Battles,'" Xinhua, April 2, 2018, http://www.xinhuanet.com/english/2018-04/02/c_137083515.htm.
142. See, for example, National Development and Reform Commission, National Energy Administration, and Ministry of Environmental Protection, "The Energy Industry's Work Program for Strengthening Air Pollution Prevention" (能源行业加强大气污染防治工作方案; Nengyuan hangye jiaqiang daqi wuran fangzhi gongzuo fang'an), March 24, 2014, http://www.gov.cn/xinwen/2014-05/16/content_2680846.htm.
143. State Council of the People's Republic of China, "Air Pollution Prevention and Control Action Plan" (大气污染防治行动计划; Daqi wuran fangzhi xingdong jihua), September 10, 2013, http://www.gov.cn/zwqk/2013-09/12/content_2486773.htm.
144. Qiang Zhang et al., "Drivers of Improved PM2.5 Air Quality in China from 2013 to 2017," Proceedings of the National Academy of Science of the United States of America, December 3, 2019, <https://www.pnas.org/content/116/49/24463.abstract?etoc>.
145. State Council of the People's Republic of China, "Air Pollution Prevention," September 10, 2013. See also Feng Hao, "China Releases 2020 Action Plan for Air Pollution," China Dialogue, July 6, 2018, <https://chinadialogue.net/en/pollution/10711-china-releases-2-2-action-plan-for-air-pollution/>.
146. Feng Hao, "China Releases 2020 Action Plan," July 6, 2018.
147. "Four Central State-Owned Enterprises Including CNPC Signed the Capital Air Pollution Prevention and Control Major Energy Security Project Task Letter" (中国石油等四央企签首都大气污染防治重大能源保障项目任务书; Zhong shiyou deng si yangqi qian shoudu da wuqi fangzhi da nengyuan baozhang xiangmu renwu shu), China Business Network (第一财经; Diyicai), September 23, 2013, <https://www.yicai.com/news/3019815.html>.
148. National Development and Reform Commission, National Energy Administration, and Ministry of Environmental Protection, "The Energy Industry's Work Program," 2 and 13.
149. Ministry of Environmental Protection et al., "Comprehensive Action Plan for Controlling Air Pollution in Beijing, Tianjin, Hebei and Surrounding Regions in Autumn 2017 and Winter 2018" (京津冀及周边地区2017 - 2018年秋冬季大气污染综合治理攻坚行动方案; Jing-Jin-Ji ji zhoubian diqu 2017-2018 nian qiu dong li daqi wuran zonghe zhili xingdong fang'an), August 21, 2017, https://www.mee.gov.cn/gkml/hbb/bwj/201708/t20170824_420330.htm.



150. Feng Hao, “China Releases 2020 Action Plan,” July 6, 2018.
151. State Council of the People’s Republic of China, “Three-Year Action Plan for Winning the Blue Sky War” (打赢蓝天保卫战三年行动计划; Da ying lantian baowei zhan san nian xingdong jihua), July 3, 2018, http://www.gov.cn/zhengce/content/2018-07/03/content_5303158.htm.
152. “Wan Gang Puts 7 Major Questions and 2 Suggestions for Fuel Cell Vehicles” (万钢给燃料电池汽车提了7大问题和2条建议; Wan Gang gei ranliao diche qiche ti le 7 da wenti he 2 jianyi), *China Automotive News* (中国汽车报; Zhongguo qiche bao), July 1, 2018, https://m.nbd.com.cn/articles/2018-07-01/1230669.html?ulu-rcmd=0_049df_art_0_e41d42014726453b856cd488c4a340ae.
153. Echo Huang, “The Man Ushered in China’s Battery Vehicle Boom Wants to Do the Same for Fuel Cells,” Quartz, April 17, 2019, <https://qz.com/1597577/architect-of-chinas-ev-boom-now-backs-hydrogen-fuel-cells/>; “Let China’s Automobile Industry Spread Its Wings and Soar—Remember Wan Gang, Member of the Standing Committee of the Chinese People’s Political Consultative Conference” (让中国汽车工业展翅飞翔——记全国政协常委万钢; Rang Zhongguo qiche gongye zhanchi feixiang—Ji quanguo zhengxie changwei Wan Gang), CCTV International (中央国际; Zhangyang guoji), April 27, 2007, <http://news.cctv.com/china/20070427/105453.shtml>; and “Wan Gang Is the World’s Leading Electric Vehicle Visionary, Not Elon Musk,” *Toronto Star*, September 27, 2018, <https://www.thestar.com/business/technology/2018/09/27/wan-gang-is-the-worlds-leading-electric-car-visionary-not-elon-musk.html> (originally appeared in Bloomberg News).
154. Lisa Margonelli, “China’s Next Cultural Revolution,” *Wired*, April 1, 2005, <https://www.wired.com/2005/04/china-4/>, and “Wan Gang Is,” *Toronto Star*, September 27, 2018.
155. “Wan Gang Is,” September 27, 2018.
156. Scott Kennedy, “China’s Risky Drive into New-Energy Vehicles,” Center for Strategic and International Studies, November 2018, VI, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/181127_Kennedy_NEV_WEB_v3.pdf?wJboZdPX5rhUfie1yaPENws2uKUQJccQ.
157. Huang, “The Man Who Ushered,” April 17, 2019.
158. “Let China’s Automobile Industry,” April 27, 2007.
159. Huang, “The Man Who Ushered,” April 17, 2019.
160. “Wan Gang: Three Directions for the Commercialization of Hydrogen Fuel Cell Vehicles” (万钢：氢燃料电池汽车商业化的三个方向; Wan Gang” qing ranliao dianchi qiche shangyehua de san fangxiang), China Energy Storage Network (中国储能网; Zhongguo chu neng wang), June 29, 2018, <https://www.china5e.com/news/news-1032921-1.html>.
161. U.S. Department of Energy, “Alternative Fuels Data Center—Fuel Cell Electric Vehicles,” https://afdc.energy.gov/vehicles/fuel_cell.html.



162. "Fuel Cell Trucks: Solution to Heavy Duty Transport Emissions?" May 17, 2018, <https://blog.ballard.com/fuel-cell-truck>.
163. Alexander Osipovich, "NYSE Moves to Delist Chinese Oil Company," *Wall Street Journal*, February 26, 2021, <https://www.wsj.com/articles/nyse-moves-to-delist-chinese-oil-company-11614383331>.
164. Federated Hermes EOS, *Case Study: Facilitating Collaborative Engagement on Climate Change*, December 2019, <https://www.hermes-investment.com/wp-content/uploads/2019/11/collaborative-engagement-on-climate-change-case-study-dec-2019.pdf>.
165. Federated Hermes EOS, *2020 Annual Review*, 4, https://www.hermes-investment.com/ukw/wp-content/uploads/2021/03/eos_annual-review-2020-single-pages-updated.pdf.
166. This paragraph is based on Federated Hermes International, "EOS Insight—Sinopec," November 1, 2018.
167. Ibid.
168. Sinopec Corp., *2019 Communication on Progress for Sustainable Development*, 12, <http://www.sinopec.com/listco/en/Resource/Pdf/201903240310.pdf>. This report was filed with the Stock Exchange of Hong Kong on March 29, 2020.
169. China Petrochemical Corporation, *2018 Social Responsibility Report*, 38, <http://www.sinopecgroup.com/group/en/Resource/Pdf/ResponsibilityReport2018en.pdf>.
170. Federated Hermes EOS, *Case Study: Facilitating Collaborative*, December 2019.
171. Climate Action 100+, *2019 Progress Report*, 65, <https://climateaction100.files.wordpress.com/2019/10/progressreport2019.pdf>.
172. Ibid. and Principles for Responsible Investment, "PRI Awards 2019 Case Study: Facilitating Collaborative Engagement on Climate Change," September 10, 2019, <https://www.unpri.org/pri-awards-2019-case-study-facilitating-collaborative-engagement-on-climate-change/4856.article>.
173. The government of Alberta repealed the carbon tax on May 30, 2019. See Government of Alberta, "Carbon Tax Repeal," <https://www.alberta.ca/carbon-tax-repeal.aspx>.
174. CNOOC International, "Compliance through Carbon Pricing," <https://cnoocinternational.com/en/related-content/oil-sands/compliance-through-carbon-pricing>.
175. CNOOC International, *2019 Canadian Sustainability Report*, 7, <https://cnoocinternational.com/operations/americas/canada>.
176. See, for example, CNOOC Petroleum Europe Limited, *Environmental Statement 2019*, 16, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/896288/CNOOC_-_Environmental_Statement_2019.pdf, and Repsol Sinopec Resources UK, *Environmental Statement*, 7 and 19, <https://assets>.



- [publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/896314/RSRUK - Environmental Statement 2019 .pdf](https://publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/896314/RSRUK_-_Environmental_Statement_2019_.pdf).
177. INEOS, “PetroChina and INEOS Complete Transaction to Form Trading and Refining Joint Ventures Related to the Refining Operations in Grangemouth (Scotland) and Lavéra (France),” July 3, 2011, <https://www.ineos.com/news/ineos-group/petrochina-and-ineos-complete-transaction-to-form-trading-and-refining-joint-ventures-related-to-the-refining-operations/>.
 178. “Ex-Citi Director to Head PetroChina Emissions Desk,” Reuters, October 18, 2010, <https://www.reuters.com/article/carbon-petrochina-idUKLDE69H1NK20101018>; and “CNPC Trades in the EU ETS, Subject to EU Emission Reduction Mechanism” (中石油操盘EU ETS 受限欧盟减排机制; Zhongshiyou cao pan EU ETS Oumeng jian pai jizhi), *21st Century Business Herald* (21世纪经济导报; 21 shiji jingji daobao), July 4, 2011, <https://finance.qq.com/a/20110705/000347.htm>.
 179. “CNPC Trades in the EU ETS,” July 4, 2011.
 180. Chen Weiyang, “Environmental Figure: Fu Chengyu’s Environmental Life” (环境人物: 傅成玉的环保人生; Huanjing renwu: Fu Chengyu de huanbao rensheng), *China Enterprise News* (中国企业报; Zhongguo qiye bao), December 22, 2015, <https://huanbao.in-en.com/html/huanbao-2241980.shtml>.
 181. CNOOC, *2005 Sustainable Development Report* (2005年可持续发展报告; 2005 nian ke chixu fazhan baogao), 16, http://194.246.119.58/pdfs/syntao/old/%7BF365FCF8-B55F-4C92-A207-BD3B315E6CF7%7D_2005zhonghaiyou.pdf.
 182. CNOOC, *Annual Report 2007*, 23, and “CNPC Trades in the EU ETS,” July 4, 2011.
 183. Chen Yiran and Jiang Haifeng, “CNOOC’s Greenhouse Gas Inventory” (中海油的温室气体盘查; Zhonghaiyou de wenshi qiti pancha), *Carbon Market* (碳市场; tan shichang), no. 21 (October 2013), 15.
 184. Zheng Tingying and Luo Mengyan, “Fu Chengyu: China Must Become a Global Carbon Trading Center in the Future” (傅成玉: 中国未来一定要成为全球碳交易中心; Fu Chengyu: Zhongguo weilai yiding yao chengwei quanqiu tan jiaoyi shichang), *Green Living* (环境与生活; Huanjing yu shenghuo), Z1 (2021), <https://www.in-en.com/article/html/energy-2302834.shtml>.
 185. Ibid.
 186. Interview, January 23, 2020.
 187. “OGCI Reports Significant Progress on Methane and Intensity Targets,” October 19, 2020, <https://oilandgasclimateinitiative.com/ogci-reports-significant-progress-on-aggregate-upstream-methane-and-carbon-intensity-targets/>.
 188. “CNOOC: The Green Energy Dream of an Oil Giant” (中海油: 石油巨头的绿色能源梦; Zhonghaiyou: shiyou jutou de lvse nengyan meng), *Business Weekly* (商务周刊; Shangwu



- zhoukan), August 14, 2009, <https://business.sohu.com/20090814/n265952364.shtml>.
189. “CNOOC Launches Greenhouse Gas Emissions Inventory Project” (中国海油启动温室气体排放盘查项目; Zhongguo haiyou qidong wenshi qiti paifang pancha xiangmu), October 11, 2010, <http://www.sasac.gov.cn/n2588025/n2588124/c4240686/content.html>.
 190. See, for example, Sinopec chairman Fu Chengyu, “A Company That Does Not Stress Responsibility Has No Future” (中石化董事长傅成玉: 不讲责任的企业没有前途; Zhongshihua dongshizhang Fu Chengyu: bu jiang zeren de qiye meiyou qiantu), *China Youth Daily* (中国青年报; Zhongguo qingnian bao), August 5, 2013, <http://finance.sina.com.cn/leadership/crz/20130805/072216343325.shtml>.
 191. PetroChina, *2019 Environmental, Social and Governance Report*, 30.
 192. “Looking Backward and Forward at CNPC’s 40 Years of International Cooperation and Exchanges” (中国石油国际合作与交流40年回眸与展望; Zhongguo shiyou guoji hezuo yu jiaoliu 40 nian huimou yu zhanwang), CNPC News Center (中国石油新闻中心; Zhongguo shiyou xinwen zhongxin), <http://news.cnpc.com.cn/system/2018/12/11/001713422.shtml>.
 193. Chen Aizhu, “China’s 2019 Annual Crude Imports Set Record for 17th Year,” Reuters, January 14, 2020, <https://www.reuters.com/article/us-china-economy-trade-crude/chinas-2019-annual-crude-imports-set-record-for-17th-year-idUKKBN1ZDOCI>; and “Six New Records Set by Liquefied Natural Gas Industry in 2019, New IHS Markit Data Shows,” IHS Markit, January 21, 2020, https://news.ihsmarkit.com/prviewer/release_only/slug/bizwire-2020-1-21-six-new-records-set-by-liquefied-natural-gas-industry-in-2019-new-ihs-markit-data-shows.
 194. “Ma Yongsheng, Member of the National Committee,” March 7, 2021.
 195. “Implement Important Instructions, Create a Win-Win Situation and Initiate a New Phase in Exploration and Development—China National Offshore Oil Corporation Strives to Increase Domestic Offshore Oil and Natural Gas Exploration and Development Efforts to Ensure National Energy Security” (落实重要批示 创新共赢形式 开创勘探开发新局面—中国海油奋力加大国内海上油气勘探开发力度, 保障国家能源安全; Luoshi zhongyao pishi chuanguang gong ying xingshi kaichuang kantan kaifa xin jumian—Zhongguo haiyou fenli jiada guonei haishang youqi kantan kaifa lidu, baozhang guojia nengyuan anquan), *People’s Daily Online* (人民网; Renmin wang), January 1, 2019, <http://ydy.people.com.cn/n1/2019/0117/c418763-30573928.html>.
 196. “China’s Crude Oil Production, 2014–2019” (2014–2019年中国原油产量; 2014–2019 nian Zhongguo yuanyou chanliang), *International Petroleum Economics* (国际石油经济; Guoji shiyou jingji) 28, no. 4 (2020): 103, China Academic Journals.
 197. For more on this topic, see Erica Downs, “High Anxiety: The Trade War and China’s Oil and Natural Gas Supply Security,” Center on Global Energy Policy, Columbia University, November 12, 2019, <https://www.energypolicy.columbia.edu/research/commentary/high-anxiety-trade-war-and-china-s-oil-and-gas-supply-security>.
 198. “Can Shale Oil Help the ‘Big Battle’ to Increase Oil and Natural Gas Production?” (页岩油能



- 否助力油气增产“大会战”；Yeyanyou neng fou zhuli youqi zengchan ‘dahuizhan’); *Caijing* (财经), August 16, 2019, <http://m.caijing.com.cn/api/show?contentid=4610039>.
199. Ibid.
200. National Bureau of Statistics, “Energy Production in December 2019,” January 19, 2020, http://www.stats.gov.cn/english/PressRelease/202001/t20200119_1723660.html.
201. “China’s Crude Oil Production Reverses Three Consecutive Years of Decline” (中国原油产量扭转连续三年下降趋势; Zhongguo yuanyou chanliang niuzhuan lianxu san nian xia jiang qushi), CNPC News Center (中国石油新闻中心; Zhongguo shiyou xinwen zhongxin), January 15, 2020, [http://news.cnpc.com.cn/system/2020/01/15/001759872.shtml#:~:text=%E3%80%8A%E6%8A%A5%E5%91%8A%E3%80%8B%E6%98%BE%E7%A4%BA%2C2019%E5%B9%B4,%E5%A2%9E%E5%8A%A0%E4%BA%861.2%E4%B8%AA%E7%99%BE%E5%88%86%E7%82%B9%E3%80%82](http://news.cnpc.com.cn/system/2020/01/15/001759872.shtml#:~:text=%E3%80%8A%E6%8A%A5%E5%91%8A%E3%80%8B%E6%98%BE%E7%A4%BA%2C2019%E5%B9%B4,%E5%A2%9E%E5%8A%A0%E4%BA%861.2%E4%B8%AA%E7%99%BE%E5%88%86%E7%82%B9%E3%80%82;); and National Development and Reform Commission, “A Brief Profile of Natural Gas Operations in 2019” (2019年天然气运行简况; 2019 nian tianranqi yunxing jiankuang), January 21, 2020, https://www.ndrc.gov.cn/fggz/jijyxtj/mdyqy/202001/t20200121_1219615.html.
202. National Bureau of Statistics, “Above-Scale Industrial Value-Added Increased by 7.3% in December 2020” (2020年12月份规模以上工业增加值增长7.3%; 2020 nian 12 yue fen guimo yishang gongye zengjia zhi zengchang 7.3%), January 18, 2021, http://www.stats.gov.cn/tjsj/zxfb/202101/t20210118_1812427.html#:~:text=12%E6%9C%88%E4%BB%BD%EF%BC%8C%E8%A7%84%E6%A8%A1%E4%BB%A5%E4%B8%8A%E5%B7%A5%E4%B8%9A,%E6%AF%94%E4%B8%8A%E5%B9%B4%E5%A2%9E%E9%95%BF2.8%25%E3%80%82.
203. PetroChina, *2017 Sustainability Report*, 25, <http://www.petrochina.com.cn/petrochina/xhtml/images/shyhyj/2017kcxzfzbggen.pdf>.
204. International Energy Agency, *Net Zero by 2050: A Roadmap for the Global Energy Sector*, June 2021 (2nd Revision), 160–161, <https://www.iea.org/reports/net-zero-by-2050>.
205. PetroChina, *Form 20-F* for 2019, 87, <https://www.sec.gov/Archives/edgar/data/1108329/000119312520125304/d836220d20f.htm>; Sinopec Corp., *Form 20-F* for 2019, 67, https://www.sec.gov/Archives/edgar/data/1123658/000110465920045548/a19-28355_120f.htm, and CNOOC Ltd., *2020 Form 20-F*, 68, https://www.sec.gov/Archives/edgar/data/0001095595/000095010321005896/dp149282_20f.htm.
206. “China National Petroleum Corporation,” *Fortune Global 500*, 2021, <https://fortune.com/company/china-national-petroleum/global500/>; “Sinopec Group,” *Fortune Global 500*, 2021, <https://fortune.com/company/sinopec-group/global500/>; and “China National Offshore Oil Corporation,” *Fortune Global 500*, 2021, <https://fortune.com/company/china-national-offshore-oil/global500/>.
207. “Exxon Mobil,” *Fortune Global 500*, 2019, <https://fortune.com/global500/2019/exxon-mobil/>, and “Royal Dutch Shell,” *Fortune Global 500*, 2019, <https://fortune.com/global500/2019/royal-dutch-shell/>.



208. “The Party Committee of the State-Owned Assets Supervision and Administration Commission Organizes and Implements the Special Action of ‘Anti-epidemic Stabilization and Employment Expansion’” (国资委党委组织实施国资央企 “抗疫稳岗扩就业” 专项行动; Guoziwei dangwei zuzhi shishi yangqi ‘kang yi wen gangkuo jiuye’ zhuan xiang xingdong), SASAC News Center (国资委新闻中心; Guoxiwei xinwen zhongxin), March 15, 2020, <http://www.sasac.gov.cn/n2588030/n2588939/c14057055/content.html>.
209. “Anti-epidemic Employment Stabilization, ‘Three Barrels of Oil’ Start Job Expansion” (抗疫稳就业, “三桶油” 启动岗位扩招行动; Kang yi wen jiuye, ‘san tong you’ qidong gang wei kuozhao xingdong), *Jiemian News* (界面新闻; Jiemian xinwen), March 30, 2020, <https://finance.sina.com.cn/roll/2020-03-30/doc-iimxyqwa4010720.shtml>.
210. This paragraph is based on an account of the exchange in the Heilongjiang Daily, the official newspaper of Heilongjiang, the province where Daqing is located: Xu Minghui, “Representative Jiang Wanchun: Daqing Is Still a Banner and a Benchmark” (姜万春代表: 大庆依然是一面旗帜、一个标杆; Jiang Wanchun daibiao: Daqing yiran shi yi mian qizhi yi ge biagan), *Heilongjiang Daily* (黑龙江日报; Heilongjiang ribao), March 8, 2016, <https://m.dbw.cn/heilongjiang/system/2016/03/08/057123977.shtml>. The account is also described in Brian Spegele, “Where Oil Workers Have Job Security: China,” *Wall Street Journal*, March 29, 2020, <https://www.wsj.com/articles/where-oil-workers-have-job-security-china-1459267426>; and Owen Guo and Neil Gough, “As China Shifts from Exporter to Importer, Fortunes Change,” *New York Times*, October 18, 2016, <https://www.nytimes.com/2016/10/18/business/energy-environment/as-china-shifts-from-exporter-to-importer-fortunes-change.html>.
211. United States Energy Information Administration, “Spot Prices,” October 15, 2020, https://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm.
212. “CNPC Chairman Wang Yilin: Do Not Engage in Capitalist Layoffs Due to Low Oil Prices” (中石油董事长王宜林: 不因石油低价搞资本主义式裁员; Zhongshiyou dongshizhang Wang Yilin Wang Yilin: bu yin shiyou dijia gao zibenzhuyishi caiyuan), *Observer* (观察者; guanchazhe) March 10, 2016, https://www.guancha.cn/Industry/2016_03_10_353483.shtml.
213. For more on the evaluation of SOE executives, see Li-Wen Lin, “Revisiting Executive Pay of China’s State-Owned Enterprises: Formal Design, Fresh Data, and Further Doubts,” *UC Davis Business Law Journal* 18, no. 2 (2018/2019), <https://blj.ucdavis.edu/archives/vol-19-no-1/BLJ-19.1-Lin.pdf>.
214. State-owned Assets Supervision and Administration Commission of the State Council, “Measures for the Evaluation of the Performance of Persons in Charge of Central Enterprises” (中央企业负责人经营业绩考核办法; Zhongyang qiye zeren jingying yeji kaohe banfa), March 7, 2019, <http://www.sasac.gov.cn/n2588030/n2588954/c10652592/content.html>.
215. “The State-Owned Assets Supervision and Administration Commission and Central Enterprises Sign Letters of Responsibility” (国资委与中央企业签订经营业绩责任书; Guoziwei yu qiye qianding jingying yeji zeren shu), June 13, 2019, <http://www.gov.cn/>



- xinwen/2019-06/13/content_5399989.htm; and Zhou Xin, “China Asks State-Owned ‘National Champions’ to Help ‘Stabilize’ Economy, Boost Profits by 9 Percent in 2019,” *South China Morning Post*, June 17, 2019, <https://www.scmp.com/economy/china-economy/article/3014788/china-asks-state-owned-national-champions-help-stabilise>.
216. “The Central Economic Work Conference Was Held in Beijing; Xi Jinping and Li Keqiang Delivered Important Speeches; Li Zhanshu, Wang Yang, Wang Huning, Zhao Leji, and Han Zheng Attended the Meeting” (中央经济工作会议在北京举行 习近平李克强作重要讲话 栗战书汪洋王沪宁赵乐际韩正出席会议; Zhongyang jingji gongzuo huiyi zai Beijing juxing; Xi Jinping Li Keqiang zuo zhongyao jianghua; Li Zhanshu Wang Yong Wang Huning Zhao Lei Han Zheng chuxi huiyi), Xinhua (新华; Xinhua), December 18, 2020, http://www.xinhuanet.com/politics/leaders/2020-12/18/c_1126879325.htm.
 217. State-owned Assets Supervision and Administration Commission of the State Council, “The Meeting of the Heads of Central Enterprises Was Held in Beijing; Unswervingly Make Stronger, Better, and Bigger State-Owned Capital and State-Owned Enterprises; Ride on the Momentum to Start a New Journey of Struggle in the ‘14th Five-Year Plan’ Period” (中央企业负责人会议在京召开; 坚定不移做强做优做大国有资本和国有企业; 乘势而上开启“十四五”奋斗新征程; Zhongyang qiye fuze ren huiyi zaijing zhaokai; jiangding bugou zuoqiang zuoyou zuoda guoyou ziben guoyou qiye; chengshi er shang kaiqi “si shi wu” fendou xin zhengcheng), December 25, 2020, <http://www.sasac.gov.cn/n2588020/n2877938/n2879597/n2879599/c16316697/content.html>.
 218. “SASAC: Will and Formulate Implementation Opinions for Central Enterprises to Implement Carbon Peaking and Carbon Neutrality Targets” (国资委: 将研究制定央企落实碳达峰、碳中和要求实施意见; Guoziwei: jiang yanjiu zhiding zhongyang luoshi tan dafeng, tan zhonghe yaoqiu shishi yijian), Netease (网易; Wangyi), April 16, 2021, <https://www.163.com/money/article/G7NGRPRV002580S6.html>.
 219. “Sinopec Teamed Up with Three Authoritative Institutions to Take the Lead in Launching Research on Carbon Peaking and Carbon Neutrality” (中国石化联合三家权威机构 率先启动碳达峰与碳中和研究; Zhongguo shihua lianhe san jia quanwei jigou shuaixian qidong tan dafeng yu tanzhonghe yanjiu), Xinhua (新华网, Xinhua wang), November 24, 2020, http://www.xinhuanet.com/energy/2020-11/24/c_1126779765.htm.
 220. “CNOOC Launches a Carbon Neutrality Plan: Increase the Proportion of Clean and Low-Carbon Energy to Over 60% by the End of 2025” (中国海油启动碳中和规划: 2025年清洁低碳能源占比拟超60%以上; Zhongguo haiyou qidong tanzhonghe guihua: 2025 nian qingjie ditan nengyuan zhan bini ti 60% yishang), *Economic Observer Online* (经济观察网; jingji guancha wang), January 15, 2021, <http://www.eeo.com.cn/2021/0115/457618.shtml>; and “CNOOC Established a Clean Energy Company, Its Research and Development Areas Involve Oil and Gas Exploration, Lithium Battery Materials, Hydrogen Fuel Cells, etc.” (中海油成立清洁能源公司 研发领域涉及油气开采、锂电材料、氢燃料电池等; Zhonghaiyou chengli qingjie nengyuan gongsi yanfa lingyu sheji youqi kaicai lidian cailiao qing ranliso dianchi deng), Polaris Hydrogen Energy Network (北极星氢能网; Beijixing qing neng wang), February 1, 2021, <http://mchuneng.bjx.com.cn/mnews/20210201/1133648.shtml>.



221. “CNPC Chairman Dai Houliang’s Interview with CCTV: Ensuring National Energy Security in a Changing Situation” (中国石油董事长戴厚良央视专访：在变局中保障国家能源安全; Zhongguo shiyou dongshizhang Dai Houliang yangshi fangwen: zai bianju Zhong baozhang guojia nengyuan anquan), CCTV Finance (央视财经; Yangshi caijing), February 17, 2021, <http://www.nengyuanjie.net/article/46161.html>.
222. MengYing, “Dual-Carbon Goals,” April 29, 2021.
223. “Dai Houliang Attends ADIPEC 2020 Virtual Opening Ceremony and Virtual Strategic Conference,” November 10, 2020, <http://www.cnpc.com.cn/en/nr2020/202011/cf1e4f812bd6410b94de26e0e7a73d1b.shtml>.
224. “‘Dialogue’ Special Program—Countdown to Carbon Neutrality: The Heat of Hydrogen Energy” (“对话” 特别节目—碳中和倒计时：氢能之热; “Duihua” tebie jiemu—tanzhonghe daojiishi: qingneng zhi re), April 17, 2021, <https://v.qq.com/x/page/a3240yli7rr.html>.
225. “Chairman of CNOOC: Strive to Achieve 10% of Total Revenue from Clean Energy and New Industries in 2025” (中海油董事长：努力实现2025年清洁能源新产业收入占总收入10%; Zhonghaiyou dongshizhang: nuli shixian 2025 nian qingjie nengyuan xin changye shouru zhan zong shouru 10%), *China Energy News* (中国能源报; Zhongguo nengyuan bao), March 18, 2021, <https://finance.sina.com.cn/wm/2021-03-18/doc-ikkntiam4717774.shtml>.
226. “(Authorized to Issue) Proposals of the Central Committee of the Communist Party of China on Formulating the 14th Five-Year Plan for National Economic and Social Development and Long-Term Goals for 2035” ((授权发布) 中共中央关于制定国民经济和社会发展第十四个五年规划和二〇三五年远景目标的建议; (shouquan fabu) Zhonggong zhongyang guanyu zhiding guomin jingji he shehui fazhan di shisi ge wu nian guihua he er ling san wu nian yuanjing mubiao de jianyi), Xinhua Online (新华网; Xinhua wang), November 3, 2020, http://www.xinhuanet.com/politics/zywj/2020-11/03/c_1126693293.htm?mc_cid=afeb03209b&mc_eid=2b4248130b.
227. “Outline for the 14th Five-Year Plan,” March 13, 2021, and “Outline for the 13th Five-Year Plan for the National Economic and Social Development of the People’s Republic of China” (中华人民共和国国民经济和社会发展第十三个五年规划纲要; Zhonghua renmin gongheguo guomin jingji he shehui fazhan di shisan ge wu nian guihua gangyao), March 17, 2016, http://www.gov.cn/xinwen/2016-03/17/content_5054992.htm.
228. Hou Ruining, “The ‘Three Barrels of Oil’ Have Entered Wind Farms One after Another; What Do They Fancy?” (“三桶油” 纷纷入局风电场，看中的是什么? ; ‘San tong you’ fenfen ruju fengdian chang, kan zhong de shenmne?), Interface (界面; Jiemian), October 31, 2020, <https://www.jiemian.com/article/5202205.html>.
229. “CNOOC Battles the Wind Power Market Again, But It Has Lost an Era” (中海油再战风电市场，却已失去了一个时代; Zhonghaiyou zai zhan fengdian shichang), E-Knowler (能见; Nengjian), July 5, 2019, http://www.tanpaifang.com/qingjienengyuan/2019/0705/64487_3.html.
230. Diana Xia and Penny Chen, “China’s Wind Investment Strong Till 2022; SOEs Lead



- Solar Development,” Fitch Ratings, August 6, 2020, <https://www.fitchratings.com/research/corporate-finance/china-wind-investment-strong-till-2022-soes-lead-solar-development-06-08-2020>.
231. Diana Xia, “China’s Renewable Installations to Stay Strong; Curtailment Risk Low,” Fitch Ratings, February 1, 2021, <https://www.fitchratings.com/research/corporate-finance/china-renewable-installations-to-stay-strong-curtailment-risk-low-01-02-2021>; and Dan Murtaugh, “China Blows Past Clean Energy Record with Wind Capacity Jump,” Bloomberg, January 20, 2021, <https://www.bloomberg.com/news/articles/2021-01-20/china-blows-past-clean-energy-record-with-extra-wind-capacity>.
 232. “CNPC’s Oil, Gas Output Hits Record of TOE in 2020,” Xinhua, January 3, 2021, http://www.xinhuanet.com/english/2021-01/03/c_139637199.htm.
 233. See, for example, “China’s Crude Oil Production, 2008–2013” (2008–2013年中国原油产量; 2008–2013 nian Zhongguo yuanyou chanliang), *International Petroleum Economics* (国际石油经济; *Guoji shiyou jingji*) 22, no. 4 (2014): 92, China Academic Journals, and “China’s Crude Oil Production, 2014–2019,” 103, China Academic Journals.
 234. Yu Yang, “Is China’s Oil and Gas Enough?” (我们的油气还够吗; *Women de youqi haigou ma?*), *China Petroleum & Petrochemical* (中国石油石化; *Zhongguo shiyou shihua*), no. 12 (June 15, 2019), 20, China Academic Journals.
 235. National Development and Reform Commission, “13th Five-Year Plan,” 11.
 236. Jenny Nguyen Yang, “China’s Five Year Plans’ Review and Expansion: Natural gas ticks the box for many policy goals,” IHS Markit, April 30, 2021, <https://ihsmarkit.com/research-analysis/chinas-fiveyear-plans-review-and-expectation-natural-gas-ticks.html>.
 237. Chen Aizhu, “China CNOOC Says to Raise Gas’ Share to Half of Output by 2035,” Reuters, October 22, 2020, <https://www.reuters.com/article/us-china-cnooc-results/china-cnooc-says-to-raise-gas-share-to-half-of-output-by-2035-idUSKBN27719W>.
 238. “Zhang Yuzhuo: Sinopec Is Deploying a Large-Scale Hydrogen Energy Industry; Some Gas Stations Will Be Transformed into Hydrogen Refueling Stations” (张玉卓: 中国石化大规模布局氢能产业 部分加油站将改造为加氢站; Zhang Yuzhuo: Zhongshihua da guimo buju qingneng changye, bufen jiayouzhan jiang gaizao wei jiaqingzhan), Sina Finance (新浪财经; *Xinliang caijing*), November 19, 2020, <https://finance.sina.com.cn/chanjing/cyxw/2020-11-19/doc-iiznctke2196999.shtml>.
 239. “Zhang Rongwang: Speed Up the Use of Low-Carbon Energy Natural Gas to Buy Time for Carbon Neutrality” (张荣旺: 加快低碳能源天然气利用, 为实现碳中和争取时间; Zhang Rongwang: jia kuai di tan nengyuan tianranqi liyong, wei shixian tan zhong he zhengqu shijian), Shanghai Petroleum and Natural Gas Exchange, April 27, 2021, <https://finance.sina.com.cn/money/future/roll/2021-04-30/doc-ikmxzfmk9918071.shtml>.
 240. Oceana Zhou and Cindy Liang, “PetroChina Targets to Meet Near-Zero Carbon Emissions by Around 2050,” Platts LNG Daily, March 26, 2021, Factiva; and Qi Yu “Two Major Oil



- Companies Will Have a Profit of 40 Billion in 2020 and Increase Investment to Promote 'Carbon Neutral' Strategies" (两大石油公司 2020年盈利400亿, 加大投资推进“碳中和”战略; Liang da shiyou gongsu 2020 nian yingli 400 yi, jiada touzi tuijin 'tanzhonghe' zhanlve), *21st Century Business Herald* (21st 世纪 经济导报; 21 shiji jingji daobao), March 26, 2021, <http://www.21jingji.com/2021/3-26/zOMDEzODfMTYyMzczOA.html>.
241. Zhou and Liang, "PetroChina Targets to Meet," March 26, 2021.
242. China National Petroleum Corporation, "China Oil and Gas Methane Alliance Was Inaugurated," May 19, 2021, <http://www.cnpc.com.cn/en/nr2021/202105/98242b1b731e48a5bdd21ca711243fa7.shtml>.
243. Oil and Gas Climate Initiative, "OGCI reports significant progress on aggregate upstream methane and carbon intensity targets," October 18, 2020, <https://www.ogci.com/portfolio/ogci-reports-significant-progress-on-aggregate-upstream-methane-and-carbon-intensity-targets/>.
244. Sinopec Corp., *2020 Sustainability Report*, 34.
245. "CNPC Will Transform from an 'Oil and Gas' Supplier to an 'Integrated Energy' Supplier" (中国石油将从“油气”供应商向“综合能源”供应商转型; Zhongguo shiyou jiang cong 'youqi' gongying shang xiang 'zonghe nengyuan' gongying shang zhuanxing), China Economic News Network (中国经济新闻网; Zhongguo jingji xinwen), June 8, 2020, <http://www.nengyuanjie.net/article/37387.html>; "Sinopec Puts Forward a New Vision and Goal: To Build the World's Leading Clean Energy and Chemical Company" (中国石化提出新愿景: 打造世界领先洁净能源化工公司; Zhongguo shihua tichu xin yuanjing: dazao shijie lingxian jiejing nengyuan huagong gongsi), Xinhua (新华; Xinhua), July 21, 2020, http://www.xinhuanet.com/energy/2020-07/21/c_1126265564.htm; and Xu Jiangfeng, "How to Build a World-Class Energy Company with Chinese Characteristics?" (如何打造中国特色国际一流能源公司?; Ruhe dazao Zhongguo tese guoji yiliu nengyuan gongsi?), *21st Century Business Herald* (21世纪经济导报; 21shiji jingji daobao), February 27, 2018, <http://finance.sina.com.cn/roll/2018-02-27/doc-ifyrvspi2294920.shtml>.
246. Chen Yuqiang and Huang Qiming, "PetroChina: The Optimization and Adjustment of the Headquarters Organization System Is Fully Launched!" (中国石油: 总部组织体系优化调整全面启动!; Zhongguo shiyou: zongbu zuzhi tixi youhua tiaozheng quanmian qidong!), *China Petroleum News* (中国石油报; Zhongguo shiyou bao), April 9, 2021, <https://finance.sina.com.cn/money/future/roll/2021-04-09/doc-ikmyaawa8766850.shtml>.
247. China National Petroleum Corporation, "New Energy," https://www.cnpc.com.cn/en/renewable/common_index.shtml.
248. Xu Yine, "China's CNPC Targets Renewable Energy Drive in Structural Overhaul," Upstream, April 12, 2021, <https://www.upstreamonline.com/energy-transition/chinas-cnpc-targets-renewable-energy-drive-in-structural-overhaul/2-1-993814>.
249. See, for example, "Historic Change! PetroChina Officially Ranks Oil, Gas, and New Energy as Its Largest Business" (历史性转变! 中石油正式将油气和新能源并列为第一大业务; Lishi xing



zhuan bian! Zhong shiyou zhengshi jiang youqi he xin nengyuan binglie di yo da yewu), Eknowar (能见; Nengjian), April 9, 2021, <https://finance.sina.com.cn/stock/relnews/cn/2021-04-09/doc-ikmxzfmk5894994.shtml>.

250. CNPC Dai Houliang Attends ADIPEC 2020 Virtual Opening Ceremony and Virtual Strategic Conferences,” November 10, 2020, <http://www.cnpc.com.cn/en/nr2020/202011/cf1e4f812bd6410b94de26e0e7a73d1b.shtml>.
251. PetroChina Company Limited, “Potential Connected Transaction: Proposed Participation in the Establishment of an Oil Industry Investment Company,” Hong Kong Exchanges and Clearing Limited, April 29, 2021, <https://www1.hkexnews.hk/listedco/listconews/sehk/2021/0429/2021042901221.pdf>.
252. The Motley Fool, “PetroChina Company Limited (PTR) Q2 2021 Earnings Call Transcript,” August 28, 2021, <https://www.fool.com/earnings/call-transcripts/2021/08/28/petrochina-company-limited-ptr-q2-2021-earnings-ca/>.
253. Maryelle Demongeot, “CNOOC Raises New Energy Capex Guidance,” *International Oil Daily*, August 19, 2021, Factiva; and Zhou, “CNOOC Plans to Raise,” February 5, 2021.
254. Ng, “Chinese offshore giant CNOOC,” August 20, 2021.
255. Demongeot, “CNOOC Raises New Energy Capex Guidance,” August 19, 2021.
256. “The New Goal of the Oil Giant Sinopec: To Be China’s Largest Hydrogen Energy Company” (石油巨头中国石化的新目标: 做中国第一大氢能公司; Shiyou jutou Zhongguo shihua de xin mubiao” zuo Zhongguo di yi da qingneng gongsi), Interface News (界面新闻; Jiemian xinwen), January 21, 2021, <https://finance.sina.com.cn/tech/2021-01-21/doc-ikftpnny0252999.shtml>; and Dai Anni, Sun Jin, and Xu Zhenghui, “Sinopec Builds China’s First Hydrogen Energy “ (中国石化打造中国第一氢能公司; Zhongguo shihua dazao Zhongguo di yi qing neng gongsi), *China Petrochemical News* (中国石化报; Zhongguo shihua bao), April 26, 2021, http://www.sinopecgroup.com/group/xwzx/gsyw/20210426/news_20210426_371789179787.shtml.
257. Eric Ng, “China’s Carbon Neutral Goal: Sinopec Plans to Spend \$4.6 billion over the Next Five Years on a Supply Chain to Promote Hydrogen,” *South China Morning Post*, August 30, 2021, Factiva, <https://www.scmp.com/business/companies/article/3146870/chinas-carbon-neutral-goal-sinopec-plans-spend-30-billion-yuan>.
258. Chia, “Sinopec Throws Itself,” February 21, 2021; Hou Ruining, “The ‘Two Barrels of Oil’ Seize the Hydrogen Industry; Sinopec Plans to Deploy 1,000 Hydrogen Refueling Stations within Five Years” (“两桶油” 抢滩氢能产业, 中石化五年内要布局1000座加氢站; “liang tong you” qiangtan qingneng chan ye, Zhongshihua wu nian nei buju 1000 zuo jiaqingzhan), *Jiemian News* (界面新闻; Jiemian xinwen), February 19, 2021, <https://www.jiemian.com/article/5699242.html>; and Eric Ng, “China’s Carbon Neutral Goal,” August 30, 2021.
259. Beveridge, Ho, and Ku, “Sinopec,” March 2, 2021, 1.



260. Eric Ng, “China’s Carbon Neutral Plan,” August 30, 2021.
261. Eric Ng, “Chinese energy giant Sinopec bets future on hydrogen as it looks to reach decarbonization goals ahead of time,” *South China Morning Post*, March 29, 2021, <https://www.scmp.com/business/companies/article/3127436/chinese-energy-giant-sinopec-bets-future-hydrogen-it-looks-reach>; Maryelle Demongeot, “China’s Sinopec Sets Long-term Carbon Goals,” *International Oil Daily*, March 29, 2021, Factiva; and Eric Ng, “China’s Carbon Neutral Plan,” August 30, 2021.
262. Eric Ng, “China’s Carbon Neutral Plan, August 30, 2021.
263. In October 2020, Sinopec Capital (a joint venture between Sinopec Group and Sinopec Corp.), Enze Private “DaiEquity Fund (a subsidiary of Sinopec Capital), and Cummins (an American hydrogen technology company) signed an agreement to develop technology to produce hydrogen through electrolysis. Three months later, in January 2021, Sinopec Group convened a video meeting with four of China’s largest solar producers to seek their assistance in developing green hydrogen projects to support the 3060 goals. “Sinopec Looks beyond Oil for Growth with Hydrogen Investment,” *Caixin*, October 12, 2020, <https://www.caixinglobal.com/2020-10-12/sinopec-looks-beyond-oil-for-growth-with-hydrogen-investment-101613862.html>; Stephen Cedric Jumchai, “Sinopec Corp, Sinopec Group Announce Formation of New Venture,” S&P Global Market Intelligence, July 10, 2018, <https://www.spglobal.com/marketintelligence/en/news-insights/trending/c8OILTjSiOvI1OHv1ayAtg2>; and Eric Ng, “Fossil Fuel Giant Sinopec Teams Up with Solar Firms on ‘Green Hydrogen’ Projects to Help China on Path toward Carbon Neutrality,” *South China Morning Post*, January 8, 2021, Factiva.
264. “Sinopec to Launch,” May 25, 2021.
265. Eric Ng, “China’s Carbon Neutral Plan, August 30, 2021.
266. Zheng Xin, “Sinopec’s Carbon Capture Project On,” *China Daily*, July 6, 2021, <http://global.chinadaily.com.cn/a/202107/06/WS60e3ab29a310efa1bd65fe3e.html>.
267. Ibid.
268. Fu Hui and Qin Zihan, “Sinopec Launches China’s First Million-Ton CCUS Project” (中国石化启动我国首个百万吨级CCUS项目; Zhongguo shihua qidong Woguo ge bai wan dun ji CCUS xiangmu), *China Petrochemical News* (中国石化报; Zhongguo shihua bao), July 6, 2021, http://www.sinopecgroup.com/group/xwzx/gsyw/20210706/news_20210706_519272414965.shtml.
269. “Sinopec Begins the Construction of a Million-Ton-Level Carbon Capture, Utilization, and Storage Project” (中国石化启动百万吨级碳捕集、利用与封存项目建设; Zhongguo shihua qidong bai wan dun ji tan bu ji liyong yu fengcun xiangmu jianshe), *Xinhua* (新华; Xinhua), July 6, 2021, <http://www.xinhuanet.com/energy/20210706/9d483c3bf61742529871bb568206208d/c.html>.
270. Email from Julio Friedman, May 27, 2021.



271. "Shenhua to Launch China's First Carbon Capture Project," Reuters, April 17, 2009, <https://www.reuters.com/article/us-shenhua-carboncapture/shenhua-to-launch-chinas-first-carbon-capture-project-idUSTRE5370EY20090408>; and Dennis Best and Ellina Levine, "Facing China's Coal Future: Prospects for Carbon Capture and Storage," International Energy Agency, 2012, <https://www.reuters.com/article/us-shenhua-carboncapture/shenhua-to-launch-chinas-first-carbon-capture-project-idUSTRE5370EY20090408>.
272. The Hydrogen Energy Vision of Sinopec Head Zhang Yuzhuo" (中石化掌舵人张玉卓的氢能愿景; Zhongshihua zhangduoren Zhang Yuzho de qingneng yuanjing), International New Energy Online (国际新能源网; Guoji xin nengyuan wang), December 31, 2020, <https://newenergy.in-en.com/html/newenergy-2398684.shtml>.
273. "Zhang Yuzhuo, Li Zhenguo, Li Lianrong, and Zhang Chuanwei Share the Stage," April 18, 2021.
274. Ibid.
275. Telephone conversation with Julio Friedman, May 24, 2021.
276. "China's 'Father of EV' Urges More Hydrogen Infrastructure to Develop Fuel Cell Vehicles," Reuters, July 2, 2019, <https://www.reuters.com/article/us-china-autos-electric-hydrogen/chinas-father-of-ev-urges-more-hydrogen-infrastructure-to-develop-fuel-cell-vehicles-idUSKCN1TX17F>.
277. National Development and Reform Commission, "Outline for the 14th Five-Year Plan for the National Economic and Social Development of the People's Republic of China and Long-Term Goals for 2035" (中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要; Zhonghua renmin gongheguo guomin jingji he shehui fazhan di shisi ge wu nian guihua he 2035 nian yuanjing mubiao gangyao), March 2021, <https://www.ndrc.gov.cn/xxgk/zcfb/ghwb/202103/P020210323538797779059.pdf>.
278. See, for example, Sören Amelang, "Europe Vies with China for Clean Hydrogen Superpower Status," Clean Energy Wire, July 24, 2020, <https://www.cleanenergywire.org/news/europe-vies-china-clean-hydrogen-superpower-status>.
279. Qi Yu, "Sinopec General Manager Ma Yongsheng: Accelerate the Development of the Hydrogen Energy Industry to Ensure National Energy Security" (中石化总经理马永生: 加快氢能产业发展 保障国家能源安全: Zhongshihua zong jingli Ma Yongsheng: jiakuai qingneng changye fazhan baozhang guojia nengyuan anquan), *21st Century Business Herald* (21世纪经济报道; 21 shiji jingji baodao), March 2, 2021, <https://m.21jingji.com/article/20210302/herald/1acfa2929e080016c3f531fbc50d02c1.html>.
280. Email from Julio Friedman, July 27, 2021.
281. Dan Murtaugh, "The Chinese Government Needs to Become a Clean Energy Supermajor," Bloomberg, May 6, 2021, <https://www.bloomberg.com/news/articles/2021-05-06/the-chinese-government-needs-to-become-a-clean-energy-supermajor>.



 COLUMBIA | SIPA
Center on Global Energy Policy

