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GATEKEEPERS OF THE TRANSITION: HOW PROVINCES ARE ADAPTING TO CHINA'S NATIONAL DECARBONIZATION PLEDGES

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NOVEMBER 2021

China's centrality in the climate crisis is hard to overstate. It overtook the United States as the world's leading emitter of carbon dioxide (CO_2) 15 years ago, and after slowing in the mid-2010s, an uptick in 2018 signaled a return to significant carbon dioxide emissions growth. By 2020, China was responsible for 31 percent of global carbon emissions from fuel combustion, exceeding the combined emissions of the US, European Union, and Organisation for Economic Co-operation and Development (OECD; 41 countries).[1] In the run-up to the Paris Agreement in 2015, China pledged that its carbon dioxide emissions would peak around 2030. In a virtual address to the United Nations General Assembly on September 22, 2020, president and Chinese Communist Party general secretary Xi Jinping surprised the world with a new pledge that China would scale up its Nationally Determined Contributions and "aim to have CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060." These "30-60" targets serve as the high-level goals that structure China's economic and environmental planning at every level.

To implement their goals, China's central authorities need the support of the provinces.[2] Although China has experienced a strong centralizing trend during Xi's tenure, the provinces retain the potential to be key bottlenecks—or key partners—for the success of national policies.[3] But provincial interests and timelines do not always align with the center because their circumstances, endowments, existing infrastructures, and economies vary widely. Decarbonizing service-dominated megacities such as Beijing and Shanghai is unlike the challenge facing impoverished Gansu or retooling the demographically shrinking agricultural province of Heilongjiang.

This commentary examines provincial responses to the 30-60 neutrality and peaking pledges, focusing on provinces that face different sets of pressures and opportunities around the low-carbon transition to demonstrate the diversity of China's challenges in addressing Xi's carbon pledges. In particular, the authors analyze carbon-intensive regions of the northern industrial heartland such as Inner Mongolia, Hebei, and Shanxi as well as eastern and southern provinces that have historically relied on energy imports (particularly coal) from other provinces and countries to guarantee their energy security. This latter group includes both economic powerhouses such as Jiangsu, which is core to China's innovation and wealth creation drives, and inland provinces such as Hunan, which has a more middling economy. This investigation highlights two major themes:

- For central authorities, mandates, quantitative targets, and disciplinary inspections around energy consumption and air pollution have been important tools for securing provincial compliance with national environmental and energy goals, and they will remain so in the low-carbon transition. These tools are particularly important for provinces that face the most economically difficult transitions. One major such group is carbon-intensive northern heartland economies, such as Inner Mongolia, where a central anti-corruption campaign against the provincial coal industry has heightened the political salience of energy consumption control.
  - That said, the political pressures used to force provincial compliance bring their own risks: prompting, for instance, crude and unsustainable compliance strategies such as residential heating cutoffs or industrial power rationing. This tension will be important to watch as provincial and central leaders seek to balance decarbonization and economic growth, especially given the power shortages that have been afflicting most of the country since August.
- Provinces historically reliant on coal imports to fuel local thermal plants are shifting the energy security strategies in their five-year plans (FYPs) to emphasize alternatives such as electricity imports and renewable generation—a trend particularly evident in parts of eastern and southern China. Power shortages in provinces across the country since late 2020 can be solved without new coal additions, but coal will remain an appealing short-term fix for provinces such as Hunan with tighter supply conditions.

To analyze these provinces, the authors reviewed official documents, plans, and media coverage including leaders' speeches. Official documents and plans contain a wealth of information on the goals of higher levels of the government and the tasks of lower levels to implement them. This information includes details about explicitly stated targets and expectations, but a great deal of data can also be inferred from what is unsaid, especially by comparing newly released documents with prior iterations. The extent and content of media coverage can show which issues are highlighted and how issues are framed. To explore provincial-level variation in coverage, the authors used China National Knowledge Infrastructure's (CNKI's) provincial newspaper database to examine original stories from each province's leading newspaper during the first half of 2021. Together, these components can clarify the paths being taken and avoided by provinces as they respond to Xi's decarbonization drive.

One brief note: this commentary was in production when a wave of power shortages struck China in August and September 2021. The authors' treatment of these shortages focuses on central policy responses and their implications for initial provincial responses to the 30-60 pledges. Time and space constraints prevent us from examining the implications of provincial-level responses to the shortages as well as any changes in provincial newspaper coverage since these incidents. Both topics deserve further research.

Background

Chinese provinces are large socioeconomic units. In population terms, the median province, Shaanxi, has 39 million people—more than Poland. The largest province, Guangdong, at 126

million people, has an economy the size of Canada's. In terms of global carbon emissions, Chinese provinces are even more prominent. Emissions from fuel combustion and cement production in Hebei in 2018 reached 912 million tons (mt), greater than Germany's, largely due to the province's coal consumption, which accounts for around 90 percent of its emissions.[4] While the scale of these numbers shows their significance, the governance challenge for China comes as much from the wide range of circumstances that different provinces find themselves in. Table 1 illustrates this diversity by showing data on the level of economic development, power production, coal share, and renewable generation across 30 Chinese provinces. Map 1 shows this diversity from another perspective, indicating per capita gross domestic product (GDP) as well as total emissions for each province.

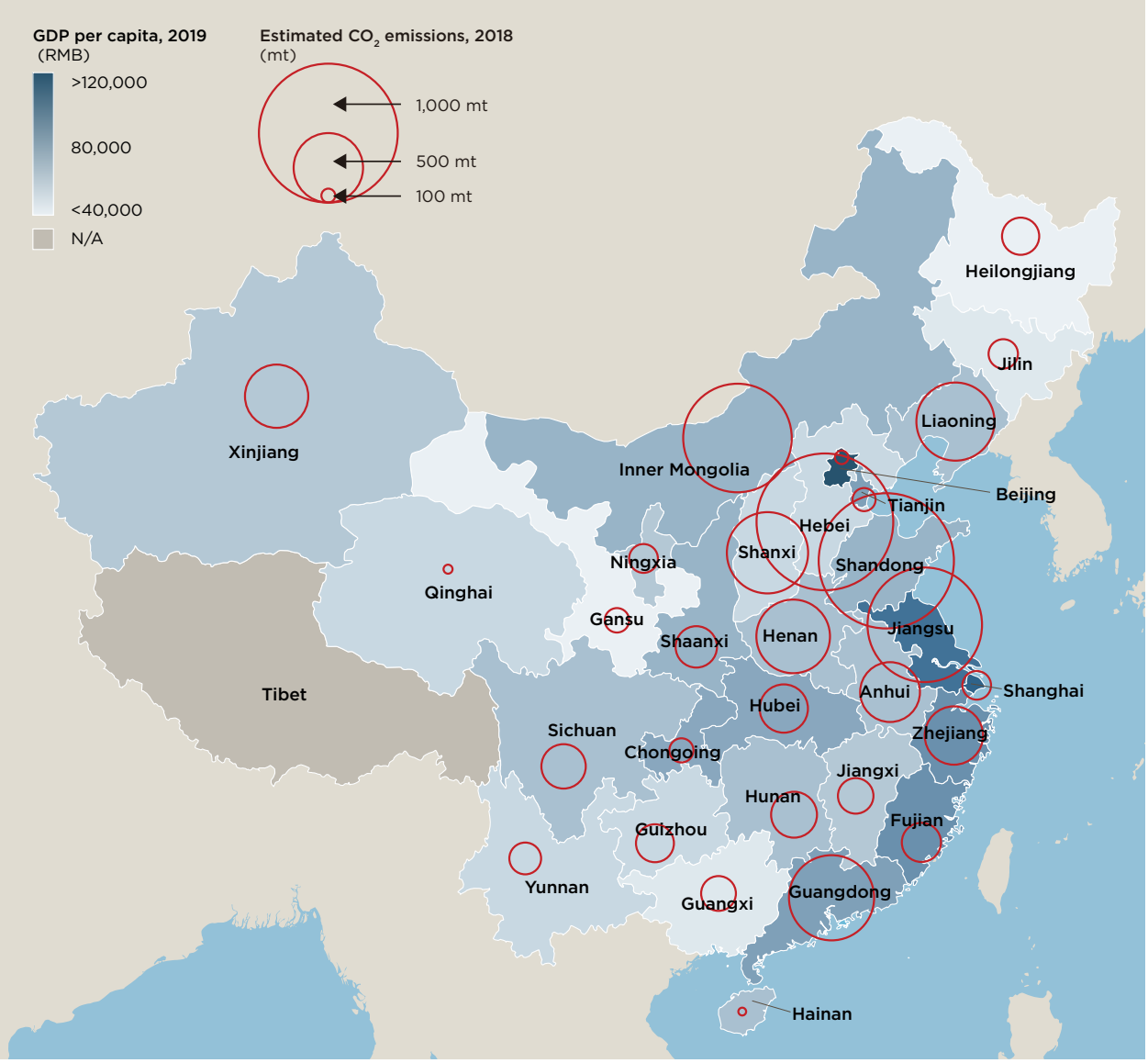
Table 1: China's provinces: Key CO_2 emissions indicators

Province	Estimated emissions (mt)	GDP (billion RMB)	Electricity generation (tWh)	Non-fossil electricity generation share	Coal output (mt)
Year	2018	2019	2019	2019	2019
Hebei	912	350	311.8	11.6%	50.8
Shandong	902	705	558.6	7.5%	118.8
Jiangsu	764	987	501.5	11.5%	11.0
Inner Mongolia	724	172	532.7	14.4%	1,035.2
Guangdong	568	1,080	472.6	29.2%	0.0
Shanxi	542	170	323.8	9.4%	971.1
Liaoning	521	249	199.6	26.1%	32.9
Henan	491	537	276.6	8.5%	108.7
Xinjiang	422	136	356.4	20.5%	237.7
Anhui	399	368	276.9	4.8%	109.9
Zhejiang	389	625	335.1	25.6%	0.0
Hubei	322	454	289.6	49.4%	0.4
Hunan	306	399	150.6	40.0%	13.7
Sichuan	296	464	367.1	86.3%	33.0
Shaanxi	276	258	211.9	12.1%	634.1
Fujian	261	423	240.6	41.6%	8.3
Guizhou	253	168	210.6	36.4%	129.7
Heilongjiang	248	135	105.7	13.8%	52.0
Jiangxi	237	247	124.2	11.7%	4.4
Guangxi	232	212	178.1	43.5%	3.6
Yunnan	212	232	325.2	90.4%	47.8
Jilin	196	117	87.2	17.4%	12.2
Ningxia	192	37	169.8	16.2%	71.7
Shanghai	191	380	79.3	1.2%	0.0
Gansu	163	87	148.0	46.5%	36.6
Chongqing	161	236	76.2	27.5%	11.5
Tianjin	154	141	71.3	1.5%	0.0
Beijing	90	354	43.1	2.5%	0.4
Qinghai	52	29	79.1	85.4%	10.1
Hainan	42	53	31.9	34.2%	0.0

Note: Emissions are estimates taken from the China Emissions Accounts and Datasets series (CEADs) and only reflect energy combustion and process emissions in cement production. They are calculated using official annual provincial energy activity statistics. Non-fossil electricity production share includes hydropower, nuclear, wind, and solar only.

Source: CEADs provincial and sectoral emissions data; National Bureau of Statistics data (indicators: regional domestic GDP 地区生产总值, electricity generation—accumulated value 发电量—累计值, hydropower generation—accumulated value 水力发电量—累计值, solar generation—accumulated value 太阳能发电量—累计值, wind generation—accumulated value 风力发电量—累计值, nuclear generation—accumulated value 核能发电量—累计值); see Appendix for full citations.

Figure 1: Provincial CO_2 emissions and GDP per capita



Note: As noted in the text, Chinese provincial CO_2 emissions are often comparable to national CO_2 emissions of other countries. In 2018, emissions from Hebei (912 mt) and Shandong (902 mt) were around 200 mt less than emissions from Japan (1,106 mt) and 200 mt greater than emissions from Germany (710 mt). Henan's emissions (491 mt) were similar to Saudi Arabia's and Mexico's, and Jilin's (196 mt) were similar to emissions from Pakistan and Ukraine. CO_2 emissions reported in this figure and in this note reflect emissions from fuel combustion as well as cement production. International emissions estimates are taken from the World Resources Institute's Climate Analysis Indicators dataset (sector "total excluding LUCF"). Chinese provincial emissions come from the CEADs database (Shan et al. 2018; Shan et al. 2020). For more details on CEADs estimates, see Shan et al. 2018 and Shan et al. 2020.

Source: Yuli Shan et al., "China CO_2 Emission Accounts 1997–2015," Scientific Data 5, 170201 (2018); Yuli

Shan, Qi Huang, Dabo Guan, and Klaus Hubacek, "China CO_2 Emission Accounts 2016–2017," Scientific Data 7, 54 (2020); National Bureau of Statistics data; World Resources Institute, Climate Analysis Indicators dataset, Climate Watch Platform, 2021, https://www.climatewatchdata.org/ghg-emissions (data sources include CO_2 Emissions from Fuel Combustion, OECD/IEA, 2021).

Provinces are more than just lines on a map and geographic groupings—they are key power players in China's political system. While Xi has centralized authority and decision-making power to himself, one man cannot govern a complex society of 1.4 billion people alone. Governance in China is dominated by the Chinese Communist Party, with party decisions guiding subsequent state actions. While ultimate authority officially rests with the 2,300-odd members of the Party Congress, in practice leadership emerges from the more elite groups of the Central Committee (about 200 people), the Politburo (25), the Politburo Standing Committee (7), and the party's leader since 2012, Xi Jinping. Inside the party-state, the central bureaucracies have relatively few staff, forcing them to rely on provinces to rule over a hierarchy of officials ruling over cities, counties, townships, and villages. Provinces serve as gatekeepers between these resource-poor localities and the full coffers of the center. The political system's design has tended to push provincial officials to favor investment-heavy development to accentuate their own interests.[5]

Annual evaluations based on highly quantified targets shape the promotion opportunities and financial rewards of these officials. For decades, the most prominent of these targets has been GDP. Environmental targets have appeared on evaluation forms since the mid-2000s, and with the urban air pollution crises of the early 2010s, they came to be viewed as critical to domestic stability. Strict attention to urban air quality led to significant improvements on that front by the start of the current decade.[6] The sources of much of the particulate matter that led to such consternation—fossil fuel burning for electricity, transportation, and industry—are also behind much of China's carbon emissions, but the improvements in air quality have not been replicated in the carbon data.

Environmental Governance and Central-Local Tensions in the North

Across much of northern China, decarbonization will force major transitions for economies with high concentrations of energy-intensive and carbon-intensive heavy industry. Provinces in this swathe of the country served as China's industrial heartland during much of the socialist era. China's economic transformation since the late 1970s has weakened the north's standing in heavy industry and, indeed, throughout the economy. The share of national secondary industry output—comprising mining, manufacturing, energy, and construction—from 15 major northern provinces dropped from 45 to 34 percent between 1992 and 2020, slightly outpacing its drop in national GDP share over the same period (43 to 35 percent).[7]

Nonetheless, northern China remains an important hub for energy-intensive and carbon-intensive heavy industry. Thirteen of the fifteen northern provinces cited above had energy intensities above China's national level of 0.50 tons of coal equivalent per RMB 1,000, including all nine of the country's most energy-intensive provinces.[8] The drivers of this high energy intensity are diverse, reflecting the diversity of the provinces themselves. Some provinces benefit from good access to coal: more than three-quarters of national coal output comes from the northern provinces of Shanxi (27 percent), Inner Mongolia (26 percent), Shaanxi (17 percent), and Xinjiang (7 percent).[9] Others remain dominant industrial producers in specific energy-intensive and

carbon-intensive sectors: the northern province of Hebei, for instance, produced around one-fourth of national steel output in 2020, and another 20 percent came from its neighbors Shanxi, Liaoning, and Shandong. Shandong and Henan are China's two leading aluminum producers, with combined annual national market shares in 2019 and 2020 of just under 40 percent.[10]

Figure 2: Provincial CO_2 emissions intensity

Note: Emissions intensity refers to emissions per unit of GDP. Emissions estimates are taken from the CEADs database (Shan et al. 2018; Shan et al. 2020) and only reflect energy combustion and process emissions in cement production. They are calculated using official annual provincial energy activity statistics. For more details, see Shan et al. 2018 and Shan et al. 2020.

Source: Yuli Shan et al., "China CO_2 Emission Accounts 1997–2015," Scientific Data 5, 170201 (2018); Yuli Shan, Qi Huang, Dabo Guan, and Klaus Hubacek, "China CO_2 Emission Accounts 2016–2017," Scientific Data 7, 54 (2020); National Bureau of Statistics data.

These circumstances will make decarbonization particularly demanding for China's north, setting up clashes between central and local interests around the pace of the energy transition. Indeed, these dynamics have already been at play in the tug-of-war between central and local authorities in several northern provinces around energy consumption and air pollution during the 13th FYP period (2016–2020). Over the past decade, Chinese authorities have largely relied on energy consumption control, in particular, to implement their climate goals. As the Chinese bureaucracy slowly operationalizes the neutrality pledge in the coming years, its existing policy framework around energy consumption will remain central for near-term carbon control, including for the peaking target.

Inner Mongolia represents an extreme example of provincial pushback to central energy consumption priorities. The province relies on abundant natural resources (including coal) and cheap electricity to attract energy-intensive industries. Researchers at the Inner Mongolia Macroeconomics Research Center report that nearly 50 percent of all large-scale industrial firms (规上工业) in the province are in sectors with high levels of energy consumption (高能耗行业), and that 87 percent of industrial added value from large and medium-sized firms in the province comes from the energy and raw materials sectors.[11] These conditions help explain why the province had overall carbon intensity in 2018 of almost four times the national average (28.6 vs. 7.6). Provincial energy intensity trends are likewise an outlier. Data from national statistical and energy authorities indicates a 21.7 percent decline in China's energy intensity between 2015 and 2019. Inner Mongolia, by contrast, saw an energy intensity increase of 1.5 percent. It was the only province with an increase and the only province judged by central authorities to have failed to meet centrally assigned "dual-control" targets for reducing energy intensity and energy consumption in 2019.[12]

Inner Mongolia was also under pressure from central authorities at this time about corruption in its coal industry.[13] A series of corruption investigations were announced in the late 2010s, targeting current and former senior officials in the province with coal industry ties.[14] In February 2020, provincial officials announced a comprehensive investigation of corruption in the sector over the past 20 years, with provincial secretary Shi Qinfeng describing corruption as "the biggest 'tumor' and source of pollution in the political environment."[15] The central pressure behind the investigation was made clear by the provincial party's newspaper, which described it as undertaken "according to suggestions from the Central Committee for Discipline and Inspection," the leader of Xi's broader anti-corruption pushes since 2012.[16] The investigation was one of several drivers of supply disruptions that cut provincial coal output by 3.3 percent in 2020, even as neighboring major producers Shanxi and Shaanxi saw 7–10 percent growth.[17]

The nexus of coal industry corruption and stubbornly high energy intensity across Inner Mongolia's economy had created pressure, even before the 30-60 pledge, for the province to transform its development model. Xi Jinping's 2019 audience with Inner Mongolian delegates to the influential "Two Sessions" central legislative meetings included a call for the province to seek a "new high-quality development path guided by ecological prioritization and green development," though these remarks focused on issues such as environmental protection and air pollution rather than climate itself.[18] A year later, in 2020, central authorities summoned Inner Mongolian officials to Beijing over the province's high energy consumption levels and publicly instructed officials to implement central mandates "without talking about special conditions or making accommodations or giving breaks."[19]

Transition pressures intensified in the months after the neutrality pledge. The pledge itself strengthened the political mandate for energy consumption control nationwide. Xi reiterated the anti-corruption campaign's importance to Inner Mongolian delegates at the "Two Sessions" central legislative meetings in March 2021, saying that he himself had reviewed the province's report to central authorities on their investigations.[20] The authorities had reported cases involving almost 1,000 cadres as of the end of April 2021.[21] Inner Mongolia's trailing 12-month coal output growth as of August 2021 was just 1.8 percent, again below Shaanxi (3.7 percent) and especially Shanxi (15.2 percent).[22]

Against this backdrop, provincial plans and regulatory pronouncements from 2021 signal an acknowledgment, at least, of Inner Mongolia's need for a new approach to growth. The provincial FYP, released in 2021, features Xi's mandate about "ecological prioritization and green development" as one of its leading themes. It is the sole task specific to the province in the plan's opening paragraph, listed alongside core national aims such as "comprehensively building a moderately prosperous society." The plan's introductory overview explicitly criticizes the province's former industrial model as "crude" in its reliance on resource exploitation for industrial development. The plan dedicates its third chapter to "a strategy for ecological civilization construction," placing the topic immediately after the introductory overview and the second chapter on innovation. The "ecological civilization construction" chapter encompasses climate as well as a wide range of other priorities, with sections on "ecological protection and restoration," "consolidating and improving environmental quality," and "advancing green, circular, low-carbon development."[23] A later section on "transforming and improving traditional industry," in the plan's fifth chapter, leads with an invocation of the neutrality and peaking goals:

> Based upon energy resource advantages, and revolving around the carbon peaking and neutrality medium- and long-term goals for confronting climate change, strengthen the dual-control system of energy consumption and force the transition and upgrading of the industrial structure.[24]

Provincial Five-Year Plans

Government authorities at a variety of levels in China—from central to local—publish five-year plans, or FYPs, to define their major economic and social governance priorities over five-year periods. Provincial FYPs, discussed in this commentary, are developed by provincial officials and are generally composed of chapters (篇), sections (章), and subsections (节). As with most Chinese government documents, analysis benefits from close reading of structure and wording that goes beyond their generally uncontroversial prose. For instance, how are priorities ordered, and how do those orders change over time? (Most provincial 14th FYPs presented innovation as their second chapter, an indicator of the national emphasis on technological upgrading for China's development.) How much discussion does a given topic receive, and where does that discussion take place? How does wording vary across different topics? (The national 14th FYP calls for "developing offshore wind in an orderly fashion [有序发展]" and "safely and appropriately advancing the construction of coastal nuclear plants"; the use of qualifiers such as "orderly" and "safely" may suggest greater interest in a strong regulatory hand around growth in these sectors.[25])

Inner Mongolia's treatment of green development and carbon emissions in its 2021 plans stands out compared to its recent annual and five-year plans. The province's 13th FYP had its "green development" chapter sixth.[26] The 14th FYP dedicates a subsection to "actively confronting climate change," whereas the 13th FYP discussed carbon emissions control primarily within sections on energy conservation.[27] The 2020 annual plan only uses the word "carbon" (碳) once, in reference to carbon emissions trading; the 2021 plan uses it five times, invoking neutrality and peaking work as part of the province's "treatment of and assault upon air pollution."[28] Both plans discuss the need to meet central energy consumption targets, but the 2021 plan calls for a much broader array of actions toward that end: driving out excess industrial capacity, canceling favorable electricity rates for high-energy industries, and energy-efficiency retrofits for industrial facilities and buildings.[29]

More concretely, the province has also announced a series of regulations in 2021 associated with these priorities—particularly energy consumption control, for which the province was publicly censured during the 13th FYP. Energy consumption control policies proposed in a February draft document aim to shut down small plants and carry out energy-efficiency retrofits in major facilities within a host of industries by 2023.[30] The province subsequently released unit-by-unit lists of industrial facilities to be closed by 2023, including 11 blast furnaces with 6.6 mt per annum of iron production capacity.[31] (The province produced 31 mt of steel in 2020, up from 17 mt in 2015.[32]) Representatives of Inner Mongolia's provincial Development and Reform Commission, its leading economic policy body, told reporters that they had previously expected to peak around 2035 but will now target peaking before 2030.[33] New energy consumption control policies do not directly mention carbon control. But Chinese media reports on the neighboring province of Shaanxi cite the neutrality and peaking pledges as drivers of stricter energy consumption control regulations in 2021. The pledges have already helped force the suspension in Shaanxi of a $20 billion state-owned coal-chemicals plant, which its sponsors have claimed is the largest under construction worldwide.[34]

Yet despite the active language in policy documents, the challenges that this transition poses to the province are evident from media coverage, or in this case, the lack thereof. Inner Mongolia saw fewer media references to the neutrality pledge than any of the other top five emitting provinces during the first half of 2021.[35] The stories that were run were thin, relative to other provinces' coverage, on the challenges that taking actions consistent with the pledges would entail for the province and its residents and businesses. The little coverage that did touch on the subject tended to frame environmental activities in the more traditional "particulate pollution" vein rather than writing directly about carbon and climate change mitigation. Beyond these few ancillary mentions of carbon neutrality, the phrase only comes up in what are essentially public relations materials for small projects by prominent corporations, such as a "carbon neutral data center" built for Alibaba.[36] An interesting exception is a piece from February 9, 2021, in which a steel industry representative positively describes policies, which in effect increase electricity prices for industry in Inner Mongolia (e.g., by canceling subsidies for specific high-electricity industries), for encouraging high-quality development and firm quality improvement.[37]

The compliance challenges for central authorities illustrated so dramatically in Inner Mongolia surface in a number of other provinces in northern China and beyond. Hebei has not seen the

dramatic underperformance in energy intensity control that Inner Mongolia has witnessed. But it has faced its own set of transition pressures around air quality and energy consumption, reflecting in part the fact that the province envelops Beijing and thus is bound up in efforts to boost air quality within the capital.[38] The neutrality pledge has intensified the enforcement of steel output restrictions used during the 13th FYP period to restrain air pollution from local mills; the coastal city of Tangshan in Hebei, responsible for 13.5 percent of national steel output in 2020, imposed production curbs of unprecedented severity for several months in spring 2021 after central inspectors found firms operating in violation of air pollution control measures.[39] Hebei's 14th FYP—approved in February 2021 before the Tangshan cuts but not released until late May—dedicated an entire section to "accelerating progress on peaking and neutrality," with subsections on peaking and neutrality policy design, renewable electricity growth, and carbon emissions and air pollution control in industry.[40] It also pronounced an intention to be "in the front ranks" nationally in peaking emissions, though this may be perfunctory; analysis of public data by the Energy Foundation suggests that Hebei and 13 other provinces have already seen peak emissions.[41]

Hebei's media discourse on carbon neutrality was more extensive during the first half of 2021 than Inner Mongolia's. One newspaper story mentioned extreme weather not simply as a future threat but as already affecting everyone today, not as a "black swan" but instead a "gray rhino."[42] It acknowledged that cutting carbon emissions will be difficult for Hebei and that most prior environmental efforts related to air quality have been "end of pipe" solutions that reduce particulate pollution but are not well targeted to carbon. This story was soon followed in the same newspaper by a series on new opportunities that this transition brings for companies and people in the province.

Hebei and Inner Mongolia's neighbor, Shanxi Province, has more recently faced its own forceful central censure over energy intensity and air pollution issues. In mid-July 2021, the Ministry of Ecology and Environment published reports from central inspection teams visiting Shanxi and seven other provinces, mostly in China's poorer interior.[43] (All eight provinces had GDP per capita figures in 2019 of at least 15 percent below the national average, with five of the eight below the national median.) The reports—which followed similar inspection reports issued for these provinces during the 13th FYP period—demanded rectification of a variety of failings by provincial and subprovincial leaders on issues including ecological preservation, pollution mitigation, and energy consumption control. Shanxi—a southern neighbor of Inner Mongolia and one of China's big three coal producers—received particularly intense criticism for its handling of energy consumption and air pollution issues.[44] Notable findings included the following:

- The province has 178 planned projects in *liang gao* industries (两高行业)—energy-intensive and pollution-intensive sectors. If these projects are implemented, their energy consumption will "significantly exceed the space for energy usage increases during the 14FYP period." Among the 178 planned projects, 101 are already under construction or are finished; 72 of those 101 have "incomplete procedures" (手续不全), indicating a failure to comply with bureaucratic requirements for their stages of construction.
- Provincial economic and energy authorities "had not paid sufficient regard to coal consumption control work, and the province's actual coal consumption figures were unclear."

- Sixty percent of sub-300-megawatt (MW) thermal power units in the province did not meet energy efficiency standards.
- The province had approved 18 iron and steel projects since 2017 under national capacity replacement regulations that required new capacity additions to be offset by capacity retirements at specified ratios. Only one of these projects actually met those ratios.

Public inspection reports are important political tools that central authorities can use to pressure local governments (and, in some cases, their allies in other central bodies) on energy and climate issues. But they have drawbacks as well, as documented in a balanced review of this reporting system by Shen and Jiang (2021).[45] For instance, the threat of weakened promotion prospects from failed inspections can encourage local authorities to adopt crude and unsustainable measures to meet central demands, such as cutting off residential coal heating access or shutting off city lights.[46] They can also encourage statistical distortion by local authorities, an ongoing issue that has delayed the rollout of China's national emissions trading scheme.[47]

Signals from central authorities in summer 2021 suggest an effort to ease some of the pressures that these tools create. At least 20 of China's 31 provinces introduced power usage restrictions during August and September 2021. These moves primarily reflected high coal prices that made generators unwilling or unable to operate as well as hydropower shortfalls that hit southwestern China. But some provinces were also facing central pressure after missing dual-control targets.[48] (The role of these targets in the shortages is hotly debated, with some analysts suggesting that their impact has been exaggerated by domestic fossil-intensive interests.[49]) In late July 2021, when shortages were affecting a narrower set of provinces, the Politburo called for "correcting campaign-style carbon reduction"; this phrase was widely interpreted as an injunction against aggressive carbon-reduction pushes undertaken by local governments without regard to other priorities.[50] It has reiterated this call as part of its response to the energy crisis, albeit as a lesser priority compared to boosting coal supply and relieving pressure on generator margins.[51] Updated central guidance in September 2021 around the dual-control system stressed the need to control *liang gao* projects but also added mechanisms for flexibility—for instance, exemptions for provinces that exceed their energy intensity targets or centrally assigned targets for renewable generation.[52]

More generally, of course, central authorities remain concerned about balancing decarbonization with economic growth and other state priorities. China's immediate goal of peaking before 2030 should be met comfortably; the International Energy Agency (IEA), for instance, projects nationwide peaking in the mid-2020s.[53] These conditions give central players latitude to decide how to prioritize different elements of the energy transition, with knock-on impacts for provincial economic transitions.[54] (As of early October 2021, for instance, Inner Mongolia has approved since late August 2021 additions of around 140 mt of coal production capacity, equivalent to around 15 percent of the province's 2020 production, as part of national efforts to boost supply.[55]) These dynamics, as well as the trade-offs around "campaign-style carbon reduction" noted above, will be crucial to watch as both central and local players seek a stable framework for decarbonization policies.

Decarbonization and Energy Security for Eastern and Southern Energy Importers

China's biggest economic powerhouses are concentrated in one of its most traditionally energy-insecure regions: its eastern and southeastern coasts.

Coal production is concentrated in the north and major hydropower resources in the inland southwest. Onshore wind and solar—the fastest-growing sources of installed capacity in China over the past decade—have reinforced the north's energy advantages, with arid and flat swathes of the north enjoying China's strongest onshore wind and solar resource potential. Inner Mongolia, for instance, was both China's second-largest coal producer and its largest wind and solar producer in 2020, accounting for 16 percent and 9 percent of national production, respectively.[56] In 2020, China's top five solar- and wind-producing provinces—accounting for 46 percent and 41 percent of national production of each type, respectively—were all located in either the north (Inner Mongolia and Hebei), the northwest (Xinjiang, Gansu, and Qinghai), or the southwest (Yunnan).[57]

Yet China's eastern and southeastern coasts include all four of China's biggest provinces by GDP and energy consumption: Shandong, Jiangsu, Zhejiang, and Guangdong. These provinces are also China's richest (excluding provincial-level cities), along with Fujian, another coastal province wedged between Zhejiang and Guangdong. These provinces have historically relied on energy imports of various kinds—importing primary energy in the form of coal and, more recently, electricity from long-distance power lines. Indeed, the four east-coast powerhouses generated power equivalent to just 70–80 percent of their own consumption in 2020. They were in the bottom six on this metric nationwide alongside their inland neighbors Jiangxi and Hunan, middling economies in south-central China.

These circumstances make energy security a particularly important policy concern for many import-dependent eastern and southern provinces as they seek to adjust their energy mixtures. Indeed, this past year has seen power shortages become an active concern across China. Cold snaps in southern China as well as surging power demand last winter and (in at least one province) pressures to meet 13th FYP dual-control targets prompted restrictions on industrial and commercial electricity use across a number of provinces.[58] The energy shortages discussed previously have highlighted these concerns. The east-coast powerhouses are by no means the only provinces suffering from this crisis; the worst-affected states have been in Northeast China, where grid operators have been forced to ration even residential power use.[59] But Shandong, Jiangsu, Zhejiang, and Guangdong introduced power usage restrictions during August and September 2021, as did Hunan.

Unsurprisingly, then, energy security features prominently in FYP energy discussions for several powerful energy-importing provinces. The 14th FYPs for both Jiangsu and Guangdong, for instance, invoke "energy security" in the titles of their sections on energy.[60] For both provinces, however, local coal generation's prominence among the listed steps for guaranteeing energy security has diminished since the last FYP. Jiangsu's 13th FYP led off its treatment of energy security with a call to "maintain safe production and optimize and adjust the energy production capacity of traditional provincial [sources of] energy including coal, oil,

and gas."[61] The corresponding discussion in the 14th FYP starts with the grid: "optimizing main grid backbones and interprovincial transmission lines" and expanding electricity imports.[62] (Of course, electricity imports can include imports of coal power.) It subsequently discusses Jiangsu's goal of strengthening its gas sector to "become an important natural gas supply pillar." Coal is treated last, and discussion only covers coal supply chains rather than generation capacity additions.[63] To be sure, local coal generation is Jiangsu's largest power source and will likely remain so in the near term.[64] But changes in the order of different topics within the plan signal a desire to reduce its reliance on this source for guaranteeing energy security.

Guangdong shows a similar shift. Its 13th FYP discussion of energy security begins with "safely developing nuclear energy" and "developing clean and efficient coal power."[65] But the discussion in the 14th FYP starts from "implementing renewable energy replacement [of fossil energy]" and invokes Xi Jinping's call from March 2021 to "establish a new-type power system with new energy as the mainstay."[66] ("New energy" is often used in Chinese policy to refer to recently developed generation technologies such as wind and solar as opposed to traditional fossil or hydro generation technologies.) Again, coal is treated last, though unlike Jiangsu, Guangdong does explicitly reference "the clean and efficient use of coal power" as opposed to just coal supply chains in its energy security discussion.[67]

The coastal powerhouses have seen some of the most robust discussion of climate change's implications and the need for carbon neutrality. Media in Jiangsu had one of the earliest comprehensive discussions of carbon neutrality. A piece from January 2021 suggested that the province should jump directly to net-zero carbon emissions and take the lead in China's carbon peaking, arguing that doing so would help the country in "becoming a powerful modern socialist country by 2050."[68] Many such stories appeared subsequently in the Jiangsu provincial party mouthpiece (新华日报), discussing the need to reduce carbon emissions in industry, construction, and transportation; connecting climate change with efforts to protect biodiversity; and positively framing carbon neutrality as an economic opportunity (rather than just a costly move away from coal) through the promotion and export of new energy equipment.

Coal's reduced prominence in these provincial plans should not be attributed to the neutrality pledge alone. The pipeline of coal power additions contracted nationwide in the late 2010s as central authorities tightened controls over new projects after a construction boom in the mid-2010s driven by provincial interests. Open-source analysis by Global Energy Monitor (GEM) finds that new capacity proposals and new construction across the country dropped 80 percent and 72 percent, respectively, from 2015–2016 to 2018–2019.[69] Severe overcapacity within the coal sector can undercut profitability. State media reported that in 2018 around half of China's coal power firms were loss making and that liabilities-to-asset ratios across the country's entire power sector stood at 78 percent.[70] (Surging coal prices in 2021 are straining these margins even further; the China Electricity Council, the generator industry association, cites reports from some firms of 50 percent year-on-year increases in per-unit coal costs as of June 2021.[71]) National air quality action plans in 2013 and 2018 also singled out regions including Jiangsu (both years) and Guangdong (2013 only) for special treatment such as higher air quality standards and coal consumption reduction targets.[72] Since 2019, no coal power projects have appeared on Jiangsu's annual priority project lists, which provinces

use to endorse major investment projects within their jurisdictions each year.[73] Power-sector projects have instead included zero-carbon sources such as nuclear plant expansions and offshore wind additions, grid build-outs, and gas transmission and power generation facilities.

Still, shifts in FYP language should not be taken to indicate a cold-turkey break from coal. A nationwide rebound in coal power construction and permitting activity happened in 2019 and 2020 as authorities sought to weather headwinds from the US-China trade war and COVID-19.[74] As of January 2021, GEM data indicated a relatively small pipeline of new permitted coal additions in Jiangsu: 0.5 gigawatts (GW) under construction and 2.1 GW permitted against 75.2 GW operating.[75] Guangdong's 2021 major project list included no coal power projects breaking ground, whereas after 2019 and 2020, the lists included 3.3 GW and 3.5 GW of such projects, respectively.[76] (To be fair, this was not just a coal phenomenon. Guangdong included 4.9 GW of nuclear projects breaking ground in 2021, but no renewables after including 4.8 GW and 1.8 GW of offshore wind breaking ground in 2019 and 2020, respectively.) But it listed 2.6 GW of coal projects entering operation in 2021 and another 5.8 GW of continuing construction. Combined, these projects equaled 12.8 percent of the 65.7 GW of provincial coal capacity in operation recorded in GEM data as of January 2021.[77]

Nonetheless, as shares of their existing capacity, the planned coal additions among major coastal powerhouses are modest compared to the aims of many provinces in interior China. The three major coal-producing provinces of Inner Mongolia, Shanxi, and Shaanxi had 57 GW of coal additions permitted or under construction as of January 2021, around 29 percent of their operating capacity. But the largest shares—with pipelines equaling 36 percent of operating capacity each—came from the south-central provinces of Hunan and Jiangxi, two energy importers that suffered from the December 2020 power shortages. Hunan's were particularly severe; restrictions on commercial and industrial power use were announced a week before they were adopted across most other affected provinces, and on December 19 grid operators announced a "wartime situation" (战时状况) in their efforts to protect residential power access.[78] The province's straits reflected the cold snap and power demand surge affecting much of southern and central China, as well as unique factors such as long-term underperformance from the province's ultra-high-voltage transmission line dedicated to power imports. But they also reflected an unusually challenging climate for coal power operations, which face elevated coal prices from long-distance transportation as well as suppressed operating hours from competition with the province's plentiful hydropower resources.[79] National installed thermal power capacity (almost entirely coal) grew by 12 percent from 2016 to 2019, but Hunan's fell by 1.8 percent over the same period; it was one of only three provinces to see a decline, along with fellow southern hydropower giants Sichuan and Yunnan.[80]

Hunan's 14th FYP reflects its concerns about energy security, with endorsements of significant fossil expansion and limited attention to carbon emissions. Its major energy subsection—"consolidate the energy security network" (夯实能源保障网)—leads with strengthening its import access but proceeds to a detailed discussion of steps to ensure that coal can better serve as the system's backbone reliability guarantor.[81] These steps included completing four ongoing coal-plant construction projects and advancing early stage work on another three; the seven combined would entail 13.3 GW of total additions in a province with 22.8 GW of operating coal capacity.[82]

To be clear, the pipelines of coal projects in Hunan, Guangdong, and elsewhere do not mean that coal additions are the only ways these provinces can address power shortages. Indeed, as noted above, coal power across China suffers from severe overcapacity, and further additions will only strain margins further. Power shortages reflect supply shortfalls for meeting peak demand that, as many analysts have argued, could be met more effectively through institutional reforms that strengthen grid flexibility—for instance, by strengthening incentives for retrofitting existing coal plants for more flexible operations, reducing barriers to interprovincial power trade, and boosting distributed renewables development.[83] Ongoing reforms on these fronts have proceeded unevenly amid resistance from vested interest groups, though the August-September crisis appears to have prompted real progress in some of these areas.[84]

Hunan's 14th FYP also deals much less with carbon emissions than those of the other provinces reviewed in this report. The plan does not include a stand-alone paragraph or subsection on climate change, as is done in the plans of Inner Mongolia, Shanxi, Hebei, Guangdong, and Jiangsu.[85] Instead, the end of its subsection on "advancing circular, low-carbon development" includes one sentence on carbon emissions containing five brief injunctions: for instance, "cut emissions intensity," "implement the national carbon emissions peaking plan," and "actively construct a national climate investment and finance pilot."[86] By contrast, Shanxi's paragraph on advancing peaking and neutrality work includes six sentences covering issues from accelerating coal consumption peaking to strengthening emissions monitoring and evaluation mechanisms.[87] Guangdong's eight-sentence paragraph features injunctions ranging from introducing a joint system for controlling emissions intensity and total emissions (similar to the dual-control energy targets) to establishing a provincial carbon capture "testing platform."[88] Jiangsu's four-sentence paragraph likewise invokes the establishment of dual-control targets for carbon emissions and calls for establishing greenhouse gas emissions standards for major industries and products.[89] The gap between these provinces and Hunan in their FYP language is also consistent with the Energy Foundation's analysis on emissions trajectories, which includes Hunan among the provinces set for "late peaks" owing to "unbalanced resource endowments" and "underdeveloped economies."[90]

Conclusion

China's 30-60 pledge was formulated in a highly centralized manner by senior leadership, supported by a research team at Beijing's elite Tsinghua University.[91] But implementing this commitment will require decades of coordinated campaigns across China's bureaucracy. Provincial leaders are key power brokers in this system. The ability of central authorities to bend national emissions toward zero will rest in part on their ability to enlist provincial leaders in these efforts. But China's provinces are diverse—ranging from depressed ex-industrial hubs in the northeast to hydropower bases in the southwest and economic powerhouses on the east coast—and the challenges and opportunities in their efforts to decarbonize can vary enormously.

Focused on two groups of provinces—the industrial heartlands of northern China and the energy-importing provinces of eastern and southern China—this commentary has highlighted several ways in which provinces will help determine the success of China's decarbonization

efforts. In the north, cutting carbon emissions requires a dramatic transformation of the energy-intensive, carbon-intensive development models on which local officials have relied for economic growth. Pressures around that transformation predate the 30-60 pledge but have been intensified by the new targets. The most dramatic responses so far have come from Inner Mongolia, the site of a major anti-corruption campaign in the provincial coal sector; its development plans and regulatory announcements are signs of its intention to more seriously tackle the painful work of economic transformation. Near-term implementation of the pledges—in the north and throughout the country—is likely to build on the center's existing mix of quantitative targets and disciplinary inspections. These strategies fit well with China's political system and have delivered improvements in air quality and energy intensity over the past decade. But they may also incentivize sporadic short-term scrambles (or statistical fudging) to meet targets and avoid discipline, rather than encourage consistent and forward-looking measures that support the decarbonization pledge's underlying goals. The central leadership's concerns about "campaign-style carbon reductions" during this year's energy crisis highlight this tension, even if fossil-sector lobbying may be bringing the dual-control system under more criticism than it deserves.

Similarly, in the south and east, the neutrality pledge has intensified pressures on provinces that have relied on physical coal imports to reframe their energy security strategies around electricity imports and low-carbon electricity where available. The return of power shortages across the country over the past year—including in these provinces—makes energy security an immediate issue. Coal additions are not the only potential solution to these shortages. China has other tools, including expanding interprovincial power trade, instituting more flexible power dispatch protocols, and stimulating distributed renewable development. But the contentious politics of these steps explain why the traditional playbook of capacity additions may retain its appeal for at least the 14th FYP period. This playbook offers a short-term supply fix and a source of stimuli for local economies amid slowing GDP growth, and it is not necessarily incompatible with China meeting its immediate climate policy priority of peaking emissions before 2030. But if China is to meet its more ambitious, longer-term carbon neutral goals, the country will need a comprehensive shift in its energy system. It will succeed only with buy-in from the provinces—the gatekeepers of the transition.

Appendix

A. Emissions, Economic, and Energy Data Sources

This paper sources data from the following data sources for emissions, coal capacity, and energy and economic activity in China.

- **Provincial and Sectoral Emissions in China:** the China Carbon Emission Accounts and Datasets series (http://www.ceads.net/). Yuli Shan et al., "China CO_2 Emission Accounts 1997–2015," Scientific Data 5, 170201 (2018), and Yuli Shan, Qi Huang, Dabo Guan, and Klaus Hubacek, "China CO_2 Emission Accounts 2016–2017," Scientific Data 7, 54 (2020).
- **Installed and Planned Coal Capacity:** Global Energy Monitor, Global Coal Plant Tracker,

"Coal Plants in China (MW)," January 2021, accessed September 10, 2021, https://web.archive.org/web/20210422224242if_/https://docs.google.com/spreadsheets/d/1mDLafuvyiLYezFmV6VXEnjlPcMy5QftwW4J2U3Qujk0/edit#gid=0, and Global Energy Monitor, Global Coal Plant Tracker, "Coal Plants in China (MW)," July 2021, accessed September 10, 2021, https://docs.google.com/spreadsheets/d/1mDLafuvyiLYezFmV6VXEnjlPcMy5QftwW4J2U3Qujk0/edit#gid=0.

  - Global Energy Monitor's Global Coal Plant Tracker reports on the global ownership of coal plants greater than 30 MW based on open-source research and is the best public, nonsubscription plant-level database of corporate coal capacity in China.

- **Energy and Economic Activity:** these were sourced from the National Bureau of Statistics or from government statistical yearbooks.

  - NBS data came from its website (https://data.stats.gov.cn/, accessed September 10, 2021) in the following locations:

Indicator 指标	Dataset	Dataset Group
Domestic GDP (国内生产总值)	Domestic GDP (国内生产总值)	Annual Data (年度数据) Economic Accounts (国民经济核算)
Year-end permanent population (年末常住人口)	Total Population (总人口)	Annual Provincial Data (分省年度数据) Population (人口)
Regional GDP (地区生产总值)	Regional GDP (地区生产总值)	Annual Provincial Data (分省年度数据) Economic Accounts (国民经济核算)
Secondary industry added value (第二产业增加值)	Regional GDP (地区生产总值)	Annual Provincial Data (分省年度数据) Economic Accounts (国民经济核算)
Raw coal production—accumulated value (原煤产量——累计值)	Raw Coal (原煤)	Monthly Provincial Data (分省月度数据) Energy (能源) Major Energy Product Output (能源主要产品产量)
Crude steel production (粗钢产量)	Industrial Product Output (工业产品产量)	Annual Provincial Data (分省年度数据) Industry (工业)
Aluminum materials production—accumulated value (铝材产量——累计值)	Aluminum (铝材)	Monthly Provincial Data (分省月度数据) Industry (工业) Major Energy Product Output (能源主要产品产量)
Electricity generation—accumulated value (发电量——累计值)	Electricity Generation (发电量)	Monthly Provincial Data (分省月度数据) Energy (能源) Major Energy Product Output (能源主要产品产量)
Electricity consumption (电力消费量)	Major Energy Product Consumption (主要能源产品消费量)	Annual Provincial Data (分省年度数据) Energy (能源)

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Indicator 指标	Dataset	Dataset Group
Hydropower generation —accumulated value (水力发电量——累计值)	Hydropower Generation (水力发电量)	Monthly Provincial Data (分省月度数据) Energy (能源) Major Energy Product Output (能源主要产品产量)
Solar generation— accumulated value (太阳能发电量——累计值)	Solar Generation (水力发电量)	Monthly Provincial Data (分省月度数据) Energy (能源) Major Energy Product Output (能源主要产品产量)
Wind generation— accumulated value (风力发电量——累计值)	Electricity Generation (风力发电量)	Monthly Provincial Data (分省月度数据) Energy (能源) Major Energy Product Output (能源主要产品产量)
Nuclear generation— accumulated value (核能发电量——累计值)	Nuclear Electricity Generation (核能发电量)	Monthly Provincial Data (分省月度数据) Energy (能源) Major Energy Product Output (能源主要产品产量)

Data drawn from statistical yearbooks included the following:

Indicator 指标	Dataset	Dataset Group
Total energy consumption (能源消费总量)	"Energy Consumption by Province and Type" (国内生产总值)	**2019:** Liu Wenhua (刘文华) ed., China Energy Statistics Yearbook 2020 (中国能源统计年鉴 2020), 4-14 **2015 to 2018:** Liu Wenhua (刘文华) ed., China Energy Statistics Yearbook 2019 (中国能源统计年鉴2019), 4-22 to 4-25.
Installed thermal capacity ((发电装机容量（火电）)	"Installed Thermal Capacity by Region" (分地区发电装机容量（火电）)	Yang Kun (杨昆) ed., China Electricity Statistics Yearbook 2020 (中国电力统计年鉴2020), 2-5.

B. Five-Year Plans

The following provincial five-year plan outlines, annual plans, and major project lists (重大项目名单) are cited in this paper (note that the 13th FYP outlines cover 2016–2020 and the 14th FYP outlines cover 2021–2025):

Guangdong Province

- **13th FYP:** "Guangdong Province Outline of 13th Five-Year Plan for Economic and Social Development" (广东省国民经济和社会发展第十三个五年规划纲要), January 13, 2018, accessed September 10, 2021, http://www.gd.gov.cn/gkmlpt/content/0/146/post_146576.html#7.
- **14th FYP:** "Guangdong Province Outline of 14th Five-Year Plan and 2035 Long-Term Goals for Economic and Social Development" (广东省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), April 25, 2021, accessed September 10, 2021, http://www.gd.gov.cn/zwgk/wjk/qbwj/yf/content/post_3268751.html.

- 2019–2021 Major Project Lists
  - **2019:** "Guangdong Province 2019 Major Project Plan" (广东省2019年重点建设项目计划), March 21, 2019, accessed September 10, 2021, http://drc.gd.gov.cn/ywtz/content/post_2264242.html.
  - **2020:** "Guangdong Province 2020 Major Project Plan" (广东省2020年重点建设项目计划), March 15, 2020, accessed September 10, 2021, http://drc.gd.gov.cn/ywtz/content/post_2915278.html.
  - **2021:** "Guangdong Province 2021 Major Project Plan" (广东省2021年重点建设项目计划表), March 15, 2021, accessed September 10, 2021, http://drc.gd.gov.cn/gkmlpt/content/3/3253/post_3253184.html#877.

Hebei Province

- **14th FYP:** "Hebei Province Outline of 14th Five-Year Plan and 2035 Long-Term Goals for Economic and Social Development" (河北省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纲要), May 29, 2021, accessed September 10, 2021, http://hbrb.hebnews.cn/pc/paper/c/202105/29/content_86825.html.

Hunan Province

- **14th FYP:** "Hunan Province Outline of 14th Five-Year Plan and 2035 Long-Term Goals for Economic and Social Development" (湖南省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纲要), March 25, 2021, accessed September 10, 2021, http://www.hunan.gov.cn/xxgk/tzgg/szbm/202103/t20210325_15073892.html.
- **2021 Major Project List:** Hunan Province Development and Reform Commission, "2021 Major Project List" (2021年省重点建设项目名单), February 25, 2021, accessed September 10, 2021, http://fgw.hunan.gov.cn/fgw/xxgk_70899/tzgg/202102/t20210225_14611166.html.

Inner Mongolia Autonomous Region

- **13th FYP:** "Inner Mongolia Autonomous Region Outline of 13th Five-Year Plan for Economic and Social Development" (内蒙古自治区国民经济和社会发展第十三个五年规划纲要), March 2021, accessed May 26, 2021, https://www.ndrc.gov.cn/fggz/fzzlgh/dffzgh/201606/P020191104643414271152.pdf.
- **14th FYP:** "Inner Mongolia Autonomous Region Outline of 14th Five-Year Plan and 2035 Long-Term Goals for Economic and Social Development" (内蒙古自治区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), February 7, 2021, accessed September 10, 2021, http://www.nmg.gov.cn/zwgk/zfxxgk/zfxxgkml/202102/t20210210_887052.html.
- **2020 Annual Plan:** "Inner Mongolia Autonomous Region 2020 Economic and Social Development Plan" (2020年内蒙古自治区国民经济和社会发展计划), January 22, 2021, accessed September 10, 2021, https://www.nmg.gov.cn/zfbgt/zwgk/zzqwj/202012/t20201208_315189.html.

- **2021 Annual Plan:** "Inner Mongolia Autonomous Region 2021 Economic and Social Development Plan" (2021年内蒙古自治区国民经济和社会发展计划) February 5, 2021, accessed September 10, 2021, http://www.nmg.gov.cn/zwgk/zfxxgk/zfxxgkml/202102/t20210209_886583.html.

Jiangsu Province

- **13th FYP:** "Jiangsu Province Outline of 13th Five-Year Plan for Economic and Social Development" (江苏省国民经济和社会发展第十三个五年规划纲要), March 18, 2016, accessed September 10, 2021, http://www.jiangsu.gov.cn/art/2016/4/20/art_46606_2556039.html.
- **14th FYP:** "Jiangsu Province Outline of 14th Five-Year Plan and 2035 Long-Term Goals for Economic and Social Development" (江苏省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纲要), February 19, 2021, accessed September 10, 2021, https://baijiahao.baidu.com/s?id=1693073223056161309&wfr=spider&for=pc (full text) and http://fzggw.jiangsu.gov.cn/art/2021/3/1/art_284_9683575.html (plan publication date).
- 2019–2021 Major Project Lists
  - **2019:** "Jiangsu Province 2019 Major Project List" (江苏省2019年重大项目名单), August 28, 2018, accessed September 10, 2021, http://fzggw.jiangsu.gov.cn/art/2019/8/28/art_51014_8695033.html.
  - **2020:** "Jiangsu Province 2020 Major Project List" (江苏省2020年重大项目名单), February 21, 2020, accessed September 10, 2021, http://fzggw.jiangsu.gov.cn/art/2020/2/21/art_4591_8979642.html.
  - **2021:** "Jiangsu Province 2021 Major Project List" (江苏省2020年重大项目名单), March 30, 2021, accessed September 10, 2021, http://www.jiangsu.gov.cn/art/2021/3/30/art_76852_9719921.html.

Shanxi Province

- **14th FYP:** "Shanxi Province Outline of 14th Five-Year Plan and 2035 Long-Term Goals for Economic and Social Development"(山西省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), April 9, 2021, accessed June 10, 2021, http://www.shanxi.gov.cn/sxszfxxgk/sxsrmzfzcbm/sxszfbgt/flfg_7203/szfgfxwj_7205/202104/t20210414_899516.shtml.

Notes

1. BP, *Statistical Review of World Energy 2021*, accessed October 6, 2021, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf.
2. China officially recognizes 34 provincial-level units, 22 provinces, 5 autonomous regions, 4 municipalities, and 2 special administrative regions (Hong Kong and Macau) and claims Taiwan as a twenty-third province. Our analysis focuses on and uses "provinces" to refer to

the 31 units of the People's Republic of China mainland, although Tibet is usually excluded due to missing data.

3. See, e.g., Kyle A. Jaros and Yeling Tan, "Provincial Power in a Centralizing China: The Politics of Domestic and International 'Development Space,'" *China Journal* 83 (2020): 79–104.

4. For Hebei emissions statistics, see the China Carbon Emission Accounts and Dataset series (full citation in Appendix, Part A). German CO_2 emissions from energy combustion and industrial processes in 2018 were 710 mt. World Resources Institute, Climate Analysis Indicators data set, Climate Watch Platform, 2021, https://www.climatewatchdata.org/ghg-emissions (with data sourced from "CO_2 Emissions from Fuel Combustion," OECD/IEA, 2021).

5. Jaros and Tan, "Provincial Power," 79–104.

6. Energy Policy Institute at the University of Chicago, Air Quality Life Index project, "China: National Air Quality Action Plan (2013)," accessed September 10, 2021, https://aqli.epic.uchicago.edu/policy-impacts/china-national-air-quality-action-plan-2014/.

7. National Bureau of Statistics (NBS) data (indicators: secondary industry value added [第二产业增加值] and domestic GDP [国内生产总值]). Appendix, Part A, provides details on the locations of all the indicators cited in this paper from the NBS or statistical yearbooks. The provinces identified in this paper as "northern" are all provinces or provincial-level cities (excluding Tibet) in four economic regions defined by the NBS:

   - **Coastal North (北部沿海):** Hebei and Shandong, as well as the provincial-level cities of Beijing and Tianjin
   - **Northeast (东北地区):** Liaoning, Jilin, and Heilongjiang
   - **Northwest (大西北地区):** Xinjiang, Qinghai, Ningxia, and Gansu (this region also includes Tibet)
   - **Yellow River Midstream (黄河中游):** Inner Mongolia, Shanxi, Shaanxi, and Henan

   This definition roughly accounts for eastern China with the traditional use of the Qin Mountains and the Huai River as the dividing line between north and south.

8. NBS data (indicator: regional GDP [地区生产总值]) and statistical yearbook data (indicator: total energy consumption [能源消费总量]). The two northern provinces and cities with energy intensities below China's median level were Henan (0.40) and the provincial-level city of Beijing (0.21).

9. NBS data (indicator: raw coal production—accumulated value [原煤产量——累计值]).

10. NBS data (indicators: crude steel production [粗钢产量] and aluminum materials production—accumulated value [铝材产量☒——累计值]).

11. Xu Dawei (胥大伟), "Ten Difficult Years for a Major High-Carbon Province: How Much of a Price Will Inner Mongolia Pay for Emissions Peaking?" (高碳大省的艰难十年：内蒙古将为碳达峰付出多大的代价？), *China News Weekly* (中国新闻周刊), June 1, 2021, accessed September 10, 2021, https://www.chinanews.com/cj/2021/06-01/9489898.shtml. Central authorities define these industries as including the processing of fuels including oil and coal; chemicals manufacturing; minerals processing, ferrous and nonferrous metals smelting, rolling, and processing, and electric power and heating production and supply. See, e.g., "NDRC: Clarify the Scope of High-Energy Industries" (国家发展改革委：明确高耗能行业范围), China Power Online (中国电力网), March 6, 2020, accessed September 10, 2021, http://www.chinapower.com.cn/jnhb/zcdt/20200306/9888.html.

12. National Development and Reform Commission (NDRC), "Announcement Regarding Results of Examination of 2019 Energy Consumption Total and Energy Intensity Dual-Control Goals" (关于各地区2019年度能源消费总量和强度双控目标考核结果的公告), February 2, 2021, accessed September 10, 2021 https://www.ndrc.gov.cn/xxgk/zcfb/gg/202102/t20210207_1267081.html. These targets are publicized, but the authors do not compare provincial energy intensity declines from public data against these targets because of data discrepancies that the authors were unable to reconcile. For instance, Guangdong Province reported in its 14th Five-Year Plan that it experienced a 13.56 percent decline in energy intensity between 2016 and 2019. This is significantly below its decline of 16.77 percent for those years calculated from public data. Guangdong Province 14th FYP, chapter 1, section 1, subsection 1; NBS data (indicator: regional domestic GDP [地区生产总值]); and statistical yearbook data (indicator: total energy consumption [能源消费总量]). (Full citations for all five-year plans, annual plans, and major project lists in this report are given in Appendix, Part B.)

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60. Guangdong 14th FYP, chapter 7, section 3, and Jiangsu 14th FYP, chapter 9, section 29.

61. Jiangsu 13th FYP, chapter 3, section 11, subsection 2.

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63. Jiangsu 14th FYP, chapter 9, section 29, subsection 1. The specific phrase used is "building a modern coal logistics system that is economical, high-efficiency, green, and advanced." A subsequent box (Box 19) lists several coal storage and transportation projects but no coal generation capacity projects, while including offshore wind and pumped storage capacity additions.

64. Jiangsu's thermal generation equaled 68.9 percent of its total consumption in 2020, with the remainder mostly from imports as well as small shares of local nuclear and wind power. Breakouts of different types of thermal generation are not available, but the vast majority of this power is likely to be coal. The province reported using 10.1 billion cubic feet of gas for electric power generation in 2020—enough for around 1.5 terawatt-hours (TWh) of power, assuming a very generous average heat rate of 7 metric million British thermal units per megawatt hour. Total thermal generation in the province was around 440 TWh. NBS data (indicators: electricity generation—accumulated value[发电量——累计值]; electricity

consumption [电力消费量]; hydropower generation—accumulated value [水力发电量——累计值]; solar generation—accumulated value [太阳能发电量——累计值]; wind generation—accumulated value [风力发电量——累计值]; and nuclear generation—accumulated value [核能发电量——累计值]) and Jiangsu Energy Supervision Office (江苏能源监管办), "Report on Jiangsu 2020 Natural Gas Consumption Situation" (2020年度江苏省天然气消费情况简报), National Energy Administration (国家能源局), January 21, 2021, http://jsb.nea.gov.cn/news/2021-1/20211211104413.htm.

65. Guangdong 13th FYP, chapter 8, section 2.

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70. "Losses Still around 50%, Bankruptcy and Restructuring Actions Frequent—How to Solve Coal Power Companies' Tricky Situation" (亏损面缩小仍在50%左右 破产清算动作频频——煤电企业困局如何破解), *Economic Information Daily* (经济参考报), August 22, 2019, accessed September 10, 2021, http://www.xinhuanet.com/power/2019-08/22/c_1210252090.htm, and Lauri Myllyvirta, Shuwei Zhang, and Xinyi Shen, "Analysis: Will China Build Hundreds of New Coal Plants in the 2020s?," *Carbon Brief*, March 24, 2020, accessed September 10, 2021, https://www.carbonbrief.org/analysis-will-china-build-hundreds-of-new-coal-plants-in-the-2020s. High coal prices in 2021 have intensified these pressures. See, for instance, Matthew Gray, "Feeling the Burn," *TransitionZero*, August 12, 2021, https://www.transitionzero.org/insights/feeling-the-burn.

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81. Hunan 14th FYP, chapter 4, section 16, subsection 2.

82. GEM GCPT, January 2021 data. Of the four projects to be completed, three (Yongzhou, Pingjiang, and Huarong) were listed as under construction in the GCPT database as of August 9, 2021, and the fourth (Huaihua / Shenhua Yueyang) is listed as permitted. Of the four projects that have yet to break ground, one is listed as pre-permit, one is listed as announced, and one has two units listed as pre-permit and two as announced. The

province's 2021 major project list included the Yongzhou (2 GW, slated for completion in 2021), Pingjiang (2 GW, 2023), and Huarong (2 GW, 2024) projects. GEM GCPT, July 2021 data, and Hunan 2021 Major Project List.

83. See, for instance, Rocky Mountain Institute and Energy Transitions Commission, "China Zero-Carbon Electricity Growth in the 2020s," 2021, accessed September 10, 2021, https:// rmi.org/insight/zero-carbon-electricity-growth-in-the-2020s/, chap. 4; Yuan Jiahai (袁家海) et al., "Research on Diverse Routes to Raising Power System Flexibility in China" (中国电力系统灵活性的多元提升路径研究1中国电力系统灵活性的多元提升路径研究), Greenpeace, November 2020 updated version, accessed July 12, 2021, https://www.greenpeace.org.cn/wp-content/uploads/2020/11/%E3%80%902020%E5%B9%B411%E6%9C%88%E6%9B%B4%E6%96%B0%E7%89%88%E6%8A%A5%E5%91%8A%E4%B8%8B%E8%BD%BD%E3%80%91.pdf; and Ben Caldecott et al., "Managing the Political Economy Frictions of Closing Coal in China," discussion paper with the University of Oxford Smith School of Enterprise and the Environment Sustainable Finance Programme, February 2017, accessed September 10, 2021, https://www.smithschool.ox.ac.uk/research/sustainable-finance/publications/Managing-the-political-economy-frictions-of-closing-coal-in-China-SFP-Working-Paper.pdf.

84. Since the crisis, central authorities have introduced measures to expand market-based price-setting in the power sector and strengthen flexibility retrofit mandates for coal power. The more immediate solution for crisis, however, has been boosting coal production. Measures on this front have been largely presented as temporary, so observers should watch carefully to see if authorities follow through on those claims after the winter heating crunch passes. On steps to boost coal supply, see "China's Coal Output Edges Up in August As Mines Reopen," Reuters, September 14, 2021, accessed October 6, 2021, https://www.reuters.com/article/china-economy-output-coal/chinas-coal-output-edges-up-in-august-as-mines-reopen-idUSL4N2QF0Z7. On pricing reforms and coal-power flexibility mandates, see Song Jiayin (宋佳音) and Meng Lingxi (孟令稀), "Data | 8 Provinces Nationwide Adjust Power Prices, Currently Not Touching upon Residential Power" (数据 | 全国已有8省调整电价，暂不涉及民用电), *Jiemian News* (界面新闻), October 1, 2021, accessed October 6, 2021, https://www.jiemian.com/article/6662717.html; Lantau Group, "Measures to Accelerate and Deepen Power Sector Reforms Announced in China," October 15, 2021, accessed November 12, 2021, https://www.lantaugroup.com/file/brief_china_power_sector_oct21.pdf; and NDRC and the National Energy Administration, "National Coal Unit Retrofit and Upgrading Implementation Plan" (全国煤电机组改造升级的通知), October 29, 2021, accessed November 12, 2021, https://www.ndrc.gov.cn/xxgk/zcfb/tz/202111/t20211103_1302856.html?code=&state=123.

85. Inner Mongolia 14th FYP, chapter 3, section 7, subsection 3; Shanxi 14th FYP, chapter 12, section 5, fourth paragraph ("implement Shanxi's actions on carbon peaking and carbon neutrality"); Hebei 14th FYP, chapter 12, section 42; and Jiangsu 14th FYP, chapter 12, section 41, subsection 3, second paragraph ("accelerate and advance low-carbon development").

86. Hunan 14th FYP, chapter 6, section 20, subsection 2.

87. Shanxi 14th FYP, chapter 12, section 5, fourth paragraph ("implement Shanxi's actions on carbon peaking and carbon neutrality").

88. Guangdong 14th FYP, section 14, subsection 1, first paragraph ("actively confront climate change").

89. Jiangsu 14th FYP, chapter 12, section 41, subsection 3, second paragraph ("accelerate and advance low-carbon development").

90. Zou, "There Is a Possibility."

91. Lucille Liu and Jing Li, "The Secret Origins of China's 40-Year Plan to End Carbon Emissions," Bloomberg, November 23, 2020, accessed September 10, 2021, https://phys.org/news/2020-11-secret-china-year-carbon-emissions.html.

Acknowledgments

The authors thank David Sandalow as well as two anonymous reviewers for their feedback in the drafting of this piece. They also thank the thoughtful editing support of Christina Nelson, Matthew Robinson, Jeffrey Culang, and Andrea Brody-Barre, as well as Anna Gossett for designing the maps and tables.

This commentary represents the research and views of the authors. It does not necessarily represent the views of the Center on Global Energy Policy. The commentary 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.

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