China

Because it is the largest national energy consumer and greenhouse gas emitter, energy technology decisions made in China in the coming decades have implications for environmental sustainability around the world. Some have traced the political origins of China's low carbon strategy to the emergence of what was called the "scientific viewpoint of development" (*kexue fazhanguan*) promoted by former president Hu Jintao around 2003 (Fewsmith 2004), although in practice low carbon development was already emerging by then out of market opportunities in the clean energy space supported by strategic industrial policy. China's economic growth model since the 1980s was based on the high-volume consumption of energy and raw materials, causing heavy pollution, low output, and low efficiency. In contrast, the Chinese vision of a low carbon development model is based on conservation, science, and technology.

Energy is directly tied to economic development, and the relationship between energy use and economic growth plays a crucial role in China's carbon emissions. Although China quadrupled its GDP between 1980 and 2000, it did so while merely doubling the amount of energy it consumed during that period. This allowed China's energy intensity (ratio of energy consumption to GDP) and consequently the emissions intensity (ratio of carbon dioxide-equivalent emissions to GDP) of its economy to decline sharply, marking a dramatic achievement in energy intensity gains not paralleled in any other country at a similar stage of industrialization. This achievement has important implications not just for China's economic growth trajectory, but also for the quantity of China's energy-related emissions. Without this reduction in the energy intensity of the economy, China would have used more than three times the energy that it actually expended during this period (Lewis 2007).

The twenty-first century has brought new challenges to the relationships among energy consumption, emissions, and economic growth in China. China's current environmental challenges are fueled not only by domestic demand but by the global demand for its products, and a concerted move to shift the country away from energy-intensive manufacturing and towards high value sectors was enshrined for the first time in China's five-year planning process in the 11th Five Year Plan (2006–2010). A cornerstone of this plan was the identification of low carbon technology sectors as "strategic emerging industries" (Government of the People's Republic of China (PRC) 2010). Renewable energy, and wind and solar power technologies in particular, were identified as strategic technology sectors for China. Promoting the use of renewable energy has only become more critical as concerns about climate change as well as conventional air pollutants have increased.

Mitigation

China's climate mitigation strategy is rooted in its promotion of both renewable energy and energy efficiency across sectors. Key national targets are enshrined in China's most recent five-year plans as well as a series of important new laws and related measures.

China's carbon targets have always been formulated in terms of "carbon intensity"—carbon dioxide emissions per unit of GDP—rather than absolute emissions targets. These carbon targets have been a cornerstone of the country's national climate policy as well as the pledges made to the United Nations Framework Convention on Climate Change, first in Copenhagen in 2009 and then in Paris in 2015. China's nationally determined contribution (NDC) submitted in advance of the Paris Agreement aims to reduce carbon intensity 60–65 percent from 2005 levels by 2030, to peak total CO_2 emissions by around 2030, "making best efforts to peak early" (NDRC, Department of Climate Change 2015).

When the COVID-19 pandemic hit China and the world in 2020, China experienced slowing economic growth. China was unable to meet its energy intensity target at the end of 2020, although it was able to surpass both its carbon intensity target and its non-fossil energy target. In 2021, China released its 14th Five-Year Plan (2021–2025), as well as the contours of its revised NDC. Seemingly still reeling from the pandemic, the targets were in most cases incremental improvements on the prior five years, or in other cases even less ambitious. The carbon intensity target was the same reduction rate as in the 13th FYP, and the energy intensity target was even more modest—a 13.5 percent decrease

Table 6 *Key climate and energy targets in China's 12th, 13th and 14th Five Year Plans and NDCs*

Target type	12th FYP target (2010–2015)	Actual level achieved by 2015	13th FYP target (2016–2020)	Actual achievement by 2020	14th FYP target (2021–2025)	China's original NDC (2030)	China's revised NDC (2030)
Carbon intensity	17% decrease from 2010	20% decrease from 2010	18% decrease from 2015	18.8%	18% decrease from 2020	60–65% decrease from 2005	At least 65% decrease from 2005
Energy intensity	16% decrease from 2010	18.2 % decrease from 2010	15% decrease from 2015	14%	13.5% decrease from 2020	N/A	N/A
Non-fossil share of primary energy	11.4%	12%	15%	15.9%	20%	20%	25%
Hydro power	260 GW	319 GW	350 GW	370.16 GW	TBA	N/A	N/A
Wind power	100 GW	129 GW	200 GW	281.53 GW	TBA	N/A	1,200 GW of combined wind and solar capacity
Solar power	35 GW	43 GW	100 GW (increased to 150 GW)	253.43 GW	TBA	N/A	
Nuclear	40 GW	26 GW	58 GW	49.89 GW	70 GW	N/A	N/A

Source: Lewis and Edwards (2021).

over the five-year period in contrast with the planned 15 percent decrease in the prior five-year period. China's key climate and energy targets in the 12th, 13th and 14th Five-Year Plans, as well as in its NDCs, are summarized in Table 6.

On September 22, 2020, President Xi stated that China will "aim to have CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060," positioning China to begin in the transition towards a low-carbon economy in earnest (Xi 2020). However, models demonstrate that limiting global emissions to 1.5°C would require China to reduce its emissions by somewhere between 90 percent and 112 percent (Duan et al. 2021). Such a rapid reduction in emissions would be unprecedented, and costly, requiring substantial deployment of carbon capture and negative emissions technologies.

Another major climate policy in China is the National Emissions Trading System (ETS). China's ETS was launched on December 19, 2017, following several years of experimenting with regional pilots. While China's carbon market is currently quite modest in scope, and far behind schedule from the initially proposed implementation schedule, it has been making steady strides to roll out what will ultimately be the largest carbon market in the world. By 2020, the carbon market was expected to regulate 3–4 billion tons of carbon dioxide a year making it twice as large as the EU market, with permits that are estimated to be worth up to 400 billion Yuan (US$65 billion) (Reuters 2015; Kai 2015). As of mid-2020, it was estimated that 1.28 billion tons of carbon dioxide equivalent emission are covered by the Chinese ETS, still far less than in Europe but more than in the United States and Canada (Environmental Defense Fund and Energy Research Institute 2020).

For many years, NDRC oversaw both climate and energy policy, allowing for policy coordination in the area of low carbon energy sources since China's greenhouse gas emissions are driven primarily by the large energy companies. In 2018, a new so-called "super ministry" was established to oversee environmental issues in China, The Ministry of Ecology and Environment (MEE), and climate was folded into MEE's portfolio along with the management of traditional air and water pollutants (Ma and Qin 2018). MEE is now in charge of climate policy, both

international and domestic. As a result, we have seen a de-prioritization of the Emissions Trading System by MEE to regulate carbon dioxide since it was developed and championed primarily by prior NDRC leadership, as well as some backsliding in international climate negotiations—particularly as long-time climate policy champions have retired (Jing 2019). Furthermore, MEE does not have control over coal plant approvals or clean energy support policies since energy policy still lies with NDRC, making setting ambitious climate targets far more challenging.

Adaptation

Although much of China's climate efforts have focused on greenhouse gas reduction, the Chinese government has released some policies on addressing adaptation. In 2013, the NDRC published a national strategy for climate adaptation from 2013–2020 which included goals to significantly reduce the vulnerability of climate-sensitive areas, improve monitoring and early warning capabilities for extreme weather events, and improve climate change research and forecasting capacity (National Development and Reform Commission 2013). In addition, the National Strategy for Climate Change Adaptation identified 14 pilot projects to improve climate resilience, ranging from urban infrastructure to soil conservation. In 2022, the Chinese government released a new adaptation strategy document for 2022–2035, which replaced the previous strategy and aims to improve adaptation mechanisms and monitoring capabilities at every level of government (National Development and Reform Commission 2022). The plan also outlined goals for the country to build a nationwide climate impact and risk assessment system by 2035, acknowledging that climate change has already had serious adverse impacts on China's ecological systems.

Challenges and opportunities

The Chinese government elevated the issue of climate change within the bureaucracy by forming the Leading Group on Carbon Peak and Neutrality in May 2021. Led by vice premier Han Zheng, China's climate leaders' group is leading the formulation of a roadmap and timetable to peak emissions before 2030 and achieve carbon neutrality by 2060. A few months after the leading group was formed, the Chinese government released two key high-level documents to guide China's climate policies. The first is a broad guiding document that is scarce on targets, but provides overarching principles and re-emphasizes a top-down approach to China's climate mitigation efforts (Xinhua News Agency 2021). The second document released shortly thereafter is an emissions-peaking action plan, which reiterates China's main objectives during the 14th five-year plan and China's pledges for 2030 (State Council 2021).

However, recent statements from top Chinese officials suggest that reducing carbon emissions and energy transition efforts are of second priority to ensuring economic growth and stability. President Xi has warned against "campaign-style decarbonization" that could pose a risk to economic growth and emphasized that low-carbon goals should not come at the expense of ensuring energy security (Ni 2022).

The fundamental key to decarbonization in China will be a shift away from coal. While there was a sizable and unexpected decline in coal consumption in both the power and industrial sectors in China—the two largest drivers of coal demand in China's economy—between 2013 and 2017, coal use started increasing again in 2018 and surpassed the presumed peak in 2020.

There are many pressures in the form of policy incentives targeting China's largest coal consuming sectors to reduce coal consumption. Coal power plants are being targeted by a number of government policies aimed at increasing efficiency and reducing pollution, and will likely soon be the target of carbon dioxide standards under the new national emissions trading scheme. In addition, many energy-intensive industrial sectors including iron, steel and cement plants are being ordered to shut down as part of a broader goal to transition the economy away from heavy, energy-intensive industry. However, reduced plant operation and closures around the country are putting huge pressures on local governments to deal with slowing economic growth and unemployment. Overcapacity in these sectors, and particularly an overbuild of coal plants, means there is pressure to increase coal electricity production, which is often done through the curtailment of

renewables. And the COVID-19 pandemic has created an unexpected set of economic challenges which appear to be leading to a coal resurgence.

International engagement

For many years, including during much of the 11th FYP period, China's positioning in the international climate negotiations lagged behind its domestic energy and climate action. It was not until the lead-up to the 15th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen in the fall of 2009 that China's domestic climate and energy undertakings began to make their way into the international climate negotiation process. China's increased involvement in international environmental negotiations around issues such as ozone depletion, biodiversity, and climate change has likely broadened the range of policy alternatives that China considers in response to these environmental problems, along with providing the country with access to new technologies and funds.

China's increasingly constructive engagement in international climate policy extends well outside of the UNFCCC. In 2016, China played a significant role in drafting an agreement to curb civil aviation emissions under the International Civil Aviation Organization (ICAO) and to reach the historic Kigali Amendment to the Montreal Protocol to phase down HFCs (ICAO 2016; Davenport 2016).

China has also become the focus of international cooperation on climate change and clean energy, and climate change is a cornerstone of bilateral engagement with numerous countries, owing to the increasingly dominant role the country is playing in both developing and disseminating clean energy technologies (Lewis 2023).

Future research

China is attempting to shift its enormous coal-based energy system to a low carbon system, a feat no country has yet to accomplish at this scale. It is experimenting with the large-scale deployment of renewable energy as no other country has before it. In many respects it is a de facto global laboratory, experimenting with and proving a model of a low carbon transition that will benefit the rest of the world should they follow China's path. Yet the challenges facing China's attempts at climate mitigation are both technical and political. Technical challenges are in many ways more straightforward to address. Political and institutional challenges are complex in that they require navigating the elaborate network of stakeholders and interest groups involved. These political obstacles are not only difficult to deal with, but also any progress towards removing them can be opaque and therefore difficult to assess. International cooperation focusing on China's clean energy sector has frequently targeted the technical and operational challenges at the expense of overlooking the political and institutional barriers to renewable energy development (Lewis 2023). As a result, it is important to continue to look for ways to expand international engagement with China, spanning both the technical and political challenges associated with decarbonization.

Conclusions

China's energy challenges are shaping the way its leadership is approaching climate mitigation at the domestic level, which in turn is shaping its positioning in international climate and energy engagement and in the international climate negotiations. Changes in China's domestic energy situation over the past decade, including its successes in low carbon technologies and its improved capacity to measure and predict energy and emissions trends, have permitted China to legislate with more confidence domestically, and to be more engaged internationally. Despite the real constraints that the country faces in constraining emissions growth, all signs point to an intensified, multifaceted domestic effort to promote a low carbon economy in the coming years and decades.

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