Enabling a rapid and just transition away from coal in China

Abstract: As the world’s largest coal producer, consumer, and importer, China’s transition from coal to cleaner energy sources will play a critical role in achieving global decarbonization. In this paper, we assess China’s current transition policies, barriers to the transition, reasons the transition may accelerate, and social justice issues related to the transition. We conclude with policy recommendations for facilitating a rapid and just transition.

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Climate change and China’s dependence on coal

Human-induced greenhouse gas emissions are the main cause of an average global warming of approximately 1°C since the beginning of the industrial era (1850–1900). The additional warming that is expected represents an imminent threat to human societies if it is not mitigated. Deep decarbonization of energy systems is needed to avoid the catastrophic consequences of climate change. According to the Intergovernmental Panel on Climate Change (IPCC), keeping global warming within a 1.5°C overall target (approximately 0.5°C warmer than today) requires global net anthropogenic CO₂ emissions to decline by about 45% from 2010 levels by 2030, reaching net-zero emissions by around 2050.¹

Coal is the largest source of global energy-related CO₂ emissions. Coal accounted for 44% of the historically high 33.1 GtCO₂ of global energy-related CO₂ emissions in 2018, including 10.1 GtCO₂ from coal-fired power generation and 4.5 GtCO₂ from other coal use.² Achieving the 1.5°C target requires coal and other fossil fuels to be phased out in the next 30 years. The scale of this transition would be unprecedented: 84.7% of the world’s primary energy consumption in 2018 came from coal (27.2%), natural gas (23.9%), and oil (33.6%).

China’s dependence on coal is a major hurdle to global decarbonization. In 2018, China accounted for half of global energy-related carbon emissions due to coal combustion.³ Coal has been the fundamental fuel behind China’s economic growth and the spread of electricity access to its entire population.⁴ China is now the world’s largest coal producer, consumer, and importer—consuming half of global coal production and importing 20% of global coal trade in 2018.⁵ It is also the world’s main international provider of finance for the building of new coal-fired power plants.⁶ Coal accounted for 60% of China’s primary energy in 2018, contributing 50% of the country’s fine particulate matter (PM₂.₅) pollutants and 70% of its carbon emissions.⁷

Coal’s dominance in China’s energy mix has created severe environmental and public health consequences.⁸ Outdoor air pollution has been a leading risk factor for mortality, contributing to an estimated 1.2 million premature deaths in China in 2017.⁹ Dispersed coal combustion from
small burners and residential uses is the main cause of heavy pollution in the Beijing-Tianjin-Hebei metropolitan area.\textsuperscript{10} Burning 1 metric ton of scattered coal discharges 10.7 kg of \( \text{PM}_{2.5} \) and 10.2 kg of \( \text{SO}_2 \): 49 times and 9 times higher emission rates, respectively, compared with emission rates from coal-fired power plants. In 2017, indoor pollutants emitted by Chinese households burning coal caused about 750,000 deaths from respiratory diseases.\textsuperscript{9}

Clearly coal is at the center of enormous energy, environmental, and climate challenges in China and worldwide. China’s transition away from coal is critical to addressing the global challenges as well as national and regional challenges related to air pollution, human health, and social justice. China’s ability to a rapid and just transition away from coal toward a lower-carbon energy system will have an outsized influence on global climate change mitigation and sustainable energy for all.

**China’s transition away from coal: current policies and barriers**

China has introduced policies to curb coal consumption and impacts. In 2013, The State Council released the Action Plan on Prevention and Control of Air Pollution ("大气污染防治行动计划"), which planned to constrain direct coal consumption to 65% of primary energy by 2017 through a combination of alternatives (coal to gas, coal to electricity), renewables, and energy efficiency.\textsuperscript{11} In 2014, China planned to limit coal’s share of primary energy to 62% by 2020 while introducing an ultra-low emissions policy for new coal-fired power-generating units to limit PM, \( \text{SO}_2 \), and \( \text{NO}_x \) emission concentrations to 10, 35, and 50 mg/m\(^3\) by 2020, respectively, equivalent to the emission concentrations of gas turbine.\textsuperscript{12} In 2015, China announced plans to reach peak carbon emissions by no later than 2030 while deriving 20% of its primary energy from non-fossil sources in preparation for the Paris climate talks.\textsuperscript{13} These goals were integrated into China’s intended nationally determined contributions to Paris Agreement emissions reductions. In 2017, China’s National Development and Reform Commission released the Energy Production and Consumption Revolution Strategy, 2016–2030 ("能源生产和消费革命战略 2016–2030"), which further detailed energy decarbonization development targets including non-fossil primary-energy shares of at least 15% (2020) and 20% (2030) as well as carbon reductions per GDP unit
of 60%–65% in 2030 compared with 2005 levels.\textsuperscript{14} In 2019, China’s National Energy Administration began implementing China’s Renewable Electricity Quota and Assessment Method (可再生能源电力配额制) with total and non-hydro quotas at the province level, to fulfill the non-fossil primary energy goals described above.\textsuperscript{15}

Figure 1. GDP, total energy consumption, and coal consumption in China, 2000–2018


These measures have achieved some positive outcomes. Coal use flattened out since 2013 while overall energy use and GDP rose (Figure 1).\textsuperscript{17,18} However, they appear to be inadequate for achieving the IPCC 1.5°C or even 2°C maximum-warming goals.\textsuperscript{19,20} Multiple models show that achieving these goals requires coal’s share of China’s electricity generation to approach 0% by 2050.\textsuperscript{21–23} Several barriers are impeding China’s rapid transition away from coal.

First, a rapid transition requires early retirement of substantial coal-generation capacity.\textsuperscript{24} Many studies have shown that continued operation of existing coal plants is incompatible with the 1.5°C pathway.\textsuperscript{25} However, about half of China’s coal capacity was built after 2000 (Figure 2).
Only 1% of the capacity was more than 30 years old in 2017 (Figure 3). Hence, a rapid transition away from coal requires an earlier retirement of plants than would be necessary owing to purely operational criteria.

Figure 2. China’s electric-generating capacity by initial operating year
Second, China’s coal consumption extends beyond the power sector. Power generation accounts for approximately half of China’s total coal consumption, with the rest attributed to industrial uses (e.g., coal burners and production of iron, steel, chemicals, and construction materials) and residential uses. Electrification and efficiency improvements could largely replace coal use in the building sector (coal for heating) and transport sector (coal to oil products). However, there are still significant barriers to replacing coal use in China’s industrial sector. In addition, the dispersed coal use in the residential sector is more difficult to regulate compared with the relatively centralized and well-documented power and industrial sectors.

Third, a rapid transition presents economic and social challenges including impacts on employment, local tax revenues, and existing coal-asset owners (the stranded-assets problem). In addition, the transition from dispersed residential coal to gas and electricity over the last two years has disrupted the heating supply during severe winters for much of the population which are often economic disadvantage groups.
Fourth, the motivations and incentives of key stakeholders in the coal value chain are not always aligned. The central government, which focuses on social stability and environmental regulations, often favors more stringent targets for the coal phaseout compared with local officials, who are mainly assessed with regard to economic growth and thus may be motivated to delay or weaken phaseout implementation. Coal interest groups are also resistant to the transition.

The case for a faster transition away from coal
Despite the barriers, several developments suggest that China could accelerate its transition away from coal. The coal phaseout increasingly aligns with energy economics and public-policy priorities, particularly the urgent need to cut coal-related air pollution and greenhouse gas emissions.

Coal consumption in China peaked in 2014 and has plateaued since. Slowing GDP growth, a structural shift away from heavy industries, and more proactive policies on air pollution and clean energy have all contributed to this trend. In 2017, China’s National Development and Reform Commission announced plans to cap coal power capacity at 1,100 GW and to stipulate a minimum average efficiency of 40% for all existing coal powerplants by 2020.

Declining costs for other electricity technologies are making a rapid coal phaseout more economically attractive. The levelized electricity costs of solar photovoltaics, wind, and battery storage have dropped by approximately 50%–85% since 2010. Additional projected cost reductions would present opportunities for more aggressive renewable-energy deployment and power-sector decarbonization than assumed in previous policy efforts. For example, one study suggests that continued cost trends for renewables will result in 62% of China's electricity coming from non-fossil sources by 2030 at a cost that is 11% lower than achieved through a business-as-usual approach. China’s power sector could halve its carbon emissions (compared with 2015 levels) at a cost about 6% lower compared with business-as-usual conditions. Another recent study shows the technical and economic feasibility of phasing out China’s coal power plants by
2040 if, beginning in the early 2020s, all new electricity demand is met by non-coal generators and all existing coal generation is replaced with non-coal generation at least by the end of the original coal plant depreciation schedules.\(^{35}\)

Co-benefits in terms of reduced air pollution and water use also increase the attractiveness of a rapid coal phaseout. Air pollution control is a top priority for the Chinese government. For example, the Air Pollution Prevention and Control Action Plan—issued by the State Council of China in 2013—reduced annual average concentrations of PM\(_{2.5}\) by 33.3\% in 74 key cities between 2013 and 2017. The improved air quality in 2017 reduced deaths by 47,240 in the 74 cities, compared with deaths in 2013.\(^{18}\) We use coal-consumption projections from multiple high-profile research institutions to estimate that the most aggressive coal-transition pathway would reduce premature death related to coal combustion by 224,000 in 2050, compared to the business-as-usual scenario.\(^{36-39}\) Similarly, our maximum estimated reduction in water consumption is 5 billion m\(^3\) in 2050.\(^{40-42}\) Figure 4 illustrates the ranges of potential co-benefits and impacts.
(b) Carbon emissions from coal

(c) Water consumption from coal power
Figure 4. Notable scenarios of coal consumption and their impacts in China

(d) Mortality to which coal contributes

(e) Employment in coal mining and coal power
A just transition away from coal

Transitioning rapidly away from coal presents social justice issues, particularly in relation to the potentially precipitous elimination of coal-related jobs. For example, in 2019, eight EU countries—France, Italy, Ireland, Denmark, Spain, the Netherlands, Portugal, and Finland—announced that they would phase out coal-fired electricity by 2030. Such a timeframe likely does not give workers in coal-related industries sufficient time to plan for, retrain for, and transition to new, similarly remunerative careers. For this reason, the near-term sacrifice made by workers and impacted communities for global climate stability merits societal assistance that goes beyond the usual welfare systems or social safety nets.

Coal-related employment in China has already been declining for years as China’s strategic plan to transition toward a more sustainable and service-based economy has undermined the economics of coal. After a decade of rapid expansion that helped power China’s boom, the number of workers directly employed in coal companies peaked at 5.3 million in 2013, dropping to 4.88 million in 2014 and 3.21 million in 2018. In particular, coal production and washing jobs started declining after the Chinese coal industry implemented phasing out older production capacity in 2016, making further resettlement of laid-off coal workers more difficult. Remaining coal workers are mainly those with relatively low education and skill levels. Many more coal-related jobs will disappear as the comparatively low production efficiency of China’s coal industry improves through mechanization. Employment will also decline in the coal-fired power industry, which is China’s largest coal consumer. A 2010 study by the International Labor Organization estimated that, on average, 62 workers would lose their jobs for each 10 MW in capacity closure. At the time, this meant that the phaseout of coal capacity would affect more than 350,000 workers between 2010 and 2020; only 10% of those would be reemployed in new capacities, and the remaining 90% would require employment assistance.
China’s coal-related jobs are distributed unevenly across provinces (Figure 5). For example, Shanxi is one of China’s largest coal-producing provinces. It possesses approximately one third of China’s total coal deposits, and coal is considered a source of regional identity as well as income.\(^{49}\) Shanxi’s coal-related employment followed the national growth trend through 2011. It is difficult to find precise provincial data for later years, but 2016 statistics published by the Global Subsidies Initiative and the International Institute for Sustainable Development indicated that Shanxi’s coal industry alone employed approximately 976,000 workers.\(^{50}\) The regional coal-mining employment of Shanxi constitutes almost one fifth of the industry’s total national employment.

![Figure 5. China’s employment in coal mining and coal power across provinces in 2015](image)

*Source: Coal-mining employment data are from NRDC\(^{51,52}\). Coal-power employment data are from the Center for Global Sustainability, University of Maryland.\(^{53}\)*

Employment is a key element of a just transition away from coal, which came to the fore following the Paris Agreement in the context of community renewal and the creation of high-quality
When China initiated policies to shrink its coal industry, it established policies to mitigate impacts on affected groups. The central government has promised to provide 100 billion Yuan in total for redundant coal workers since 2016. In recent years, relevant government departments have introduced policies to promote the settlement and reemployment of coal workers. For example, the central government formulates specific employment-support policies for unemployed coal workers, providing them with free employment guidance, job placement, consultation, and other services. Some subsidies are offered to laid-off coal workers who have difficulty finding jobs immediately. State-owned coal enterprises must provide skills training, such as entrepreneurship training for former employees who are willing to start their own businesses.

A just transition away from coal also relates to energy access for low-income groups that rely on abundant, cheap, and readily available coal for winter heating. From the winter of 2017 to the spring of 2018, “coal to electricity (煤改电)” and “coal to gas (煤改气)” policies were vigorously promoted in the Beijing-Tianjin-Hebei areas. However, owing to the rush for quick results and inadequate implementation, some areas in Hebei faced gas shortages, and basic winter heating supplies could not be guaranteed.

Finally, various ancillary, upstream, and downstream industries will also decline during the coal phaseout, and thus a just transition applies to them as well. The power-generation sector, coal-transportation sector, and many other industries have already experienced structural adjustments because of China’s transition.

**Conclusion and policy implications**

The scale and scope of China’s transition away from coal are unprecedented. Coal consumption peaked in the United Kingdom at 180 million metric tons of coal equivalent (MMTCE) in 1957 and in the United States at 780 MMTCE in 2007—only 6.4% and 27.9% of China’s peak coal consumption at 2800 MMTCE in 2014. The ability of China to make this dramatic transition rapidly and just will have a significant impact on how China and, to a large extent, the world use energy
and address climate change. Here we propose a few overarching strategies and implementation policies related to the transition, and we identify important unanswered questions about the transition.

**Mandate a dedicated task force or commission to facilitate the transition and serve the best interests of impacted communities and workers.** This commission should have as wide a societal and geographic representation as possible, to ensure all stakeholders are included. Designating a special task force was done in Germany, through the German Coal Commission (GCC), and in Canada, through the Task Force on Just Transition for Canadian Coal Power Workers. In the German case, the GCC not only provided guidance on labor policies, but also advised on the coal-plant retirement deadline. One way to kickstart such a commission in China would be to create a coal transition special task force in the already-functioning National Energy Commission (国家能源委员会). The task force would produce recommendations and leave implementation and enforcement details to administrators and legislators. Because the transition will cover 30 years, it also makes sense to build flexibility into the task force, including periodic milestones and revisions.

**Commit to a mid-century non-fossil energy share target.** China has a 2020 non-fossil fuel target but no 2050 goal. Because of China’s centralized political structure, commitment from the national government is essential and is accordingly held accountable by public opinion. Thus, the government is often reluctant to commit to goals that it sees as risky. However, China could set a mid-century goal that it is confident of achieving. Canada, France, Italy and the United Kingdom of the G20 have Paris Agreement compatible plans for phasing out coal before or by 2030. In the UN Climate Action Summit 2019, 65 countries and major sub-national economies such as California committed to cut greenhouse gas emissions to net zero by 2050. Even a “lowball” target could signal the progress. Germany, for example, is planning to phase out coal by 2038— not Paris Agreement compatible—and produce 80% of electricity from renewable sources by 2050. A long-term goal delivers a clear message and would help accelerate the transition away from coal and toward clean energy.
Phase out subsidies to the coal economy. China’s coal industry is already declining and shedding jobs, but China continues to subsidize it to keep it competitive. Subsidies and support to coal production and coal-fired powerplants include providing overseas financing for coal of over $9 billion/year (2016–2017 average) and subsidies of over $7 billion/year (2016–2017 average) to coal-generated electricity through funding of the state-owned enterprises. Removing coal (and other fossil-fuel) subsidies would help alternative energy sources compete on a level playing field.

Implement instrumental policies. Several additional policies would accelerate the transition. 1) Manage demand growth through efficiency. Future coal capacity is responsive to future energy demand, and energy efficiency can reduce electricity consumption by as much as 5,000 TWh in 2050 compared with a business-as-usual scenario. 2) Restrict the construction of new coal powerplants. No new coal plant should be allowed when comparable clean energy alternatives exist, which is increasingly a reality as renewable costs decline and renewable electricity achieves grid parity. 3) Allow for earlier retirement of existing coal plants, prioritizing locations and plants where the operational economics are unfavorable. Adopt a rule for coal plants to retire no later than their decommission or depreciation schedule. 4) Significantly increase investment in solar, wind, and energy storage to continue driving renewable expansion and integration.

Couple transition plans with just treatment of workers and their communities. Just-transition measures should include retraining coal workers, especially those at the beginning of their careers, in economic activities aligned to the broader economic transition and diversification strategies. One example of a feasible reemployment activity would be a new public program for environmental restoration. Appropriate programs would require skill sets similar to those coal workers already have, or present low barriers to entry. Program funding could come from a tax on pollution and carbon emissions. Such an approach would also enhance social equity, yielding a double dividend by curbing emissions while funding the just transition. Additional just-transition measures should include enhancing the social safety net of health, retirement, and
unemployment insurance at the national, provincial, and local levels. Support should be directed to workers, not corporations; otherwise, it would just be another form of subsidy to the coal industry.

Important questions about China’s transition away from coal remain to be answered, many of which revolve around the pace of technological innovation and societal changes. Disruptive technologies, such as nuclear fusion, might reshape the energy landscape and accelerate the coal transition, although uncertainty still surrounds the viability and potential timeline of commercial fusion. If coal has any future, it will be highly dependent on large-scale deployment of carbon capture, sequestration, and utilization—a technology that works but has not been proven economically viable at meaningful scales.\textsuperscript{21,27} Renewables and large-scale electricity storage have their own limitations. Challenges include developing the materials, manufacturing, installation, and integration capabilities to enable those technologies to replace coal rapidly. The lifecycle environmental impacts of battery storage also require further investigation. Finally, the transition away from coal must overcome inertia related to established social, economic, and infrastructure systems.

As the ancient Chinese philosopher Laozi (老于), one of the founders of Taoism said, “A journey of a thousand miles begins with a single step (千里之行，始于足下).” China’s has taken its first steps to phasing out coal. The journey ahead will be a winding one—but, with effective plans and policies, it may be a rapid and just one as well.

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