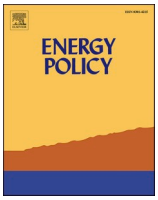
Energy Policy 163 (2022) 112797

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol



Sensitive intervention points in China's coal phaseout☆

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ARTICLE INFO

JEL classification:
Q58
Q48
Q52
D72
P48
N75
O13

Keywords:
China's climate policy
Coal transition
China's coal sector
Coal phaseout
Chinese political economy

ABSTRACT

China's investment decisions will shape the global market for coal in the coming decades, putting substantial power over global climate change mitigation in the hands of few actors. We apply the Actor-Objective-Context (AOC) framework proposed by Jakob et al. (2020) to investigate the stakeholders and interests at play in China's managed coal phaseout, consistent with the country's 2060 'carbon neutrality' target. We analyze the power dynamics between actors alongside the available policy toolkit for transitioning away from coal. This leads to several policy-relevant conclusions. First, China's central energy policy framework needs little adjustment – it is already suitable to facilitate a rapid curbing of coal market development. Instead, and secondly, the incentive structure for provincial governments and state-owned enterprises needs substantial improvement to comply with central policies. Thirdly, the most efficient and effective ways to change the incentive structure are to alter promotion criteria for Chinese provincial officials and to create compensation and investment schemes for provinces that shift away from coal.

1. Introduction

New investments in both production and consumption facilities for coal still dominate disinvestments. All climate change mitigation scenarios consistent with 1.5–2 °C targets under the Paris Agreement require coal to be phased out rapidly if sufficient mitigation is to be achieved (Parra et al., 2019). It is therefore a matter of years before the stranded assets discussion will be the most important in climate change policy. This raises the question: *why do societies continue to invest in coal plants that stand to be written off within a decade?*

Nowhere is that question more pressing and poignant than in China. China is the main driver of the global increase in demand for coal-fired power. In fact, coal-fired electricity generation would be on its way out were it not for the increase in capacity observed in China: decommissioning exceeds commissioning in the rest of the world since 2018, but this effect is offset by a substantial net increase in coal-fired electricity capacity in China, as shown in Fig. 1. In 2020, China commissioned more than five times the coal-fired electricity capacity of the rest of the world *combined* (Global Energy Monitor, 2021). As the availability of cost-competitive alternatives grows, the strength of classic economic arguments underpinning the *status quo* diminishes, and real-world considerations of political economy come into focus. Again, this holds true particularly in the Chinese case: burdened by chronic overcapacity, China has seen a multitude of bankruptcies in the coal sector in recent years (Xu and Patton, 2019). Nonetheless, China remains steadfast in pursuing new investments and greenlighting construction projects to increase its coal-fired power capacity (Standaert, 2021).

It is no exaggeration to say that Chinese investment decisions will determine the global market for coal in the coming decades. This puts substantial power over the fate of international climate change mitigation efforts in the hands of a few actors. In this paper, we will therefore investigate who those actors are and what their interests are. We will ask what institutions or individuals are best positioned to influence these decisions. Finally, we will suggest a pragmatic politico-strategic approach for those hoping to influence these processes, focusing specifically on the question: what 'sensitive intervention points' (SIPs) can

☆ The authors wish to thank Denise van der Kamp, Jonas Nahm, Ties Dams, Yangsiyu Lu, and Xiyu Jiao for helpful comments at various stages of this paper's development.

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https://doi.org/10.1016/j.enpol.2022.112797
Received 26 June 2021; Received in revised form 19 December 2021; Accepted 8 January 2022
Available online 11 February 2022

be identified to stimulate a Chinese coal phaseout? Inspired by the complex systems approach to political strategy adumbrated in Farmer et al. (2019), we seek SIPs – where relatively minor but well-targeted interventions can generate major behavioural changes and nonlinear shifts towards achieving climate mitigation goals – but tailored to China's idiosyncratic institutional context and capable of dramatically shifting administrative and investment behaviours at the large-scale coal and industrial enterprises—and provincial authorities—whose actions over the coming years will determine the pace of the country's coal phaseout.

To this end, we employ and expand upon the Actor-Objective-Context (AOC) framework recently developed in Jakob et al. (2020) and applied by the same authors to the cases of Vietnam, Indonesia and India. We believe in the necessity of cross-country comparative assessments of the political economies that will determine climate change outcomes. The effort by Jakob et al. (2020) to develop an analytic framework that is globally applicable and to provide focus to an often-dispersed research agenda is therefore laudable. We hope to contribute to this effort in two ways. First, by expanding on the framework – adding tools for analyzing the power dynamics between actors and the policy toolkit for transitioning away from coal that Jakob et al. call for. And secondly, by applying the expanded analytic framework to what is arguably both its hardest and most important object of study: China.

We will arrive at three main conclusions. First, the central energy policy framework needs little adjustment – it is already suitable to facilitate a rapid curbing of coal market development. Instead, and secondly, the incentive structure for decentral governments and state-owned enterprises to comply with central policies needs to be improved substantially. Thirdly, the most efficient and effective ways to change the incentive structure are (i) to alter promotion criteria for Chinese decentral officials and (ii) to create compensation and investment schemes for provinces that shift away from coal. These proposed institutional changes constitute 'sensitive intervention points' for global climate change mitigation: at negative economic costs and (with a functioning compensation mechanism) no harm to vested interests, mitigation at a globally significant scale can be achieved.

The paper proceeds as follows: in section 2 we explain the theoretical framework we employ to analyze the political economy of coal in China; section 3 covers the state of play in the Chinese markets for coal production, consumption and labour market, as well as the institutions that govern the policy formation process for energy and climate change issues – in short, what Jakob et al. (2020) have dubbed the 'context'. We will do so by drawing extensively on the existing literature and official sources. In section 4 we will use the Jakob et al. analytic framework to identify the actors and their objectives. We will add to the Actor-Objective-Context framework by making the power that actors have over policy and outcomes explicit, along with the relationships of power between the actors. In section 5, we will suggest a policy toolkit that is available to the Chinese state, as well as to other countries wishing to transition away from coal. In section 6 we will combine the analyses of sections 3-5 to suggest strategic avenues for policy intervention to advance the transition away from coal—or at least limit its expansion—in China.

2. Methods

2.1. Expanding the AOC framework for political economy analysis

Transitioning away from coal is a policy objective for many countries across the world, and challenges faced by governments, such as overcoming vested industrial interests and labor market immobility, are often similar. Given these similarities, the efforts by Jakob et al. (2020) to establish a common analytical framework for studying the political economy of climate change and energy policy are timely and welcome. Jakob et al. (2020) suggest carefully mapping the actors involved as well as their principal objectives, and making the context in which they operate explicit. They separate analysis of political and non-political actors, suggest common objectives both within the climate change policy domain and adjacent to or interfering with other policy goals (such as preventing environmental degradation versus maintaining gainful employment), and list the most important contextual factors to take into account.

We agree with the basic assumptions underlying the AOC framework and recognize its utility in statically mapping the political economy. We expand on it in two ways. First, by adding a more explicit and systematic analysis of the power of all actors over policy inputs and outcomes, as well as the power dynamics between the actors involved. And secondly, by providing the policy toolkit for transitioning away from coal that Jakob et al. call for in their paper.

2.2. Applying the expanded AOC framework to China

We will use this expanded framework to analyze the political economy of transitioning away from coal in China. Analyzing the political economy of China on any issue is notoriously difficult. This is illustrated by the limited literature on the political economy of coal in China, in spite of the topic's global significance. And yet, any framework for analyzing the political economy of climate change and energy policy that cannot be applied to China is of limited relevance, given China's preeminent role in determining climate outcomes over the next decade(s).

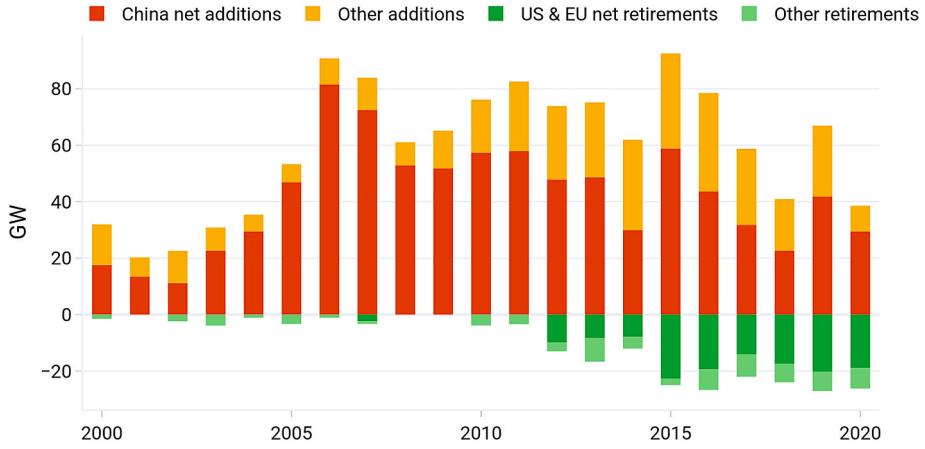

Fig. 1. China's coal capacity (additions and retirements, gigawatts)
Source: Centre for Research on Energy and Clean Air (2021).

Jakob et al. (2020) obtained their basic data through interviews with actors within the political economy of their country of study. Given the firm grip of the Chinese Communist Party over both the public sphere and appointees in influential positions, interviewing is not a reliable option in the Chinese case. Nor can public consultations, transparency records of lobbying, or requests for publicizing documents of policy considerations be relied upon.

Nevertheless, both domestic and foreign authors have made useful steps in identifying the main actors and their motives. We will gratefully use their results to provide input to the framework. In addition, we will look at coal-developments of the past decade – most importantly, the expansion of coal plants in certain provinces against the formally stated objectives of central government environmental and climate policies, and the anti-graft campaign with its strong focus on the energy sector. From official and non-official reports of these power struggles, we will deduce actor-objectives and power relations.[2]

2.3. Limitations

Our approach has several important limitations. First, without direct access to insider information on internal power struggles within the party-industry-energy nexus, academics have to be somewhat modest and prudent when making statements regarding China's political economy on coal. We do not have access to such insider information, and therefore work from second-best sources. Second, for practical reasons, the scope of the analysis in this paper is limited to domestic developments. Indeed, taking trade and foreign investments into account would render our mapping of the political economy of coal more complete. This could be a fruitful avenue for future research. Third, in recent years more detailed databases on the ownership of coal plants have come available.[3] Although insight into which legal entities formally own coal plants does not always imply factual insight into links between investors and politicians, or links between coal plant investors and the mining or industrial sector, such databases could be used for further analysis, for example of the changing role of State Owned Enterprises. This could be a useful next step in research into the political economy of the Chinese coal sector that lies outside the scope of this paper.

3. China and coal: expansion in spite of climate commitments

Below we will give the context information of Chinese energy and climate policy and the role of coal therein. We will first give an overview of the coal sector, both production and consumption, and describe economic structures and recent developments. Secondly, we will look at the energy and climate change formal policy formation process.

3.1. Overview of China's Coal sector

3.1.1. Coal production market structure: many small mines and companies, in spite of concentration efforts

Coal production in China mostly takes place in three bordering central Northern provinces: Shanxi, Inner Mongolia and Shaanxi. Between January and May of 2020, together, they accounted for over 70% of total coal production in China (Coalhub, 2020). This share stands to increase, as the National Development and Reform Commission (NDRC) announced on the June 18, 2020 that it looks to further concentrate the production of coal in these regions (National Development and Reform Commission, 2020b).

In spite of this regional concentration, there is still a lack of company-level and mine-level concentration in the Chinese coal mining sector (Yang et al., 2017). This is a result of policies in the 1980s and 1990s, when both national and provincial governments pushed for local mines to be developed to reduce energy shortages and dependencies. As a result, in 1997, the production share of the top eight companies was only 11% (Yang et al., 2017). A concentration of the market has been on the policy agenda in Beijing ever since, as concerns regarding a lack of technological development and innovation, safety and control over capacity issues have remained (Yang et al., 2017, Nahm, 2020).

Shutting down or consolidating mines can lead to local and frictional loss of employment, even if macroeconomic outcomes of the Chinese coal production sector stand to improve with consolidation and concentration (Gillich et al., 2020; Spencer et al., 2018). Consolidation and concentration may also harm private vested interests that are often well-connected and entrenched in the policy formation process on a regional level. This battle between macro goals, often publicly forwarded by Beijing, and conflicting regional interests, is a recurring theme in recent history of Chinese markets for coal.

3.1.2. Coal power market: overcapacity issues, in spite of efforts to downsize capacity

The Chinese market for coal-fired electricity is characterized by an overcapacity that is astonishing both in size and duration. Overcapacity has been increasing steadily now for around 15 years (Wang et al., 2018). By some forecasts, overcapacity was estimated to reach 200 GW in 2020 (Yuan et al., 2016) – more than the EU's total installed capacity, for comparison. Astonishingly, the average utilization rate of coal plants in China has fallen below 50 percent in recent years (China Electricity Council, 2021). The problem has been widely acknowledged by scholars (Liu et al., 2017) and the Chinese state (National Development and Reform Commission, 2020a) alike since the start of the last decade. The fact that it has endured nonetheless is a poignant fact.

One of the surprising and uneconomic results of the overcapacity in the Chinese coal market is the curtailment of renewables. The Chinese government has set specific targets of 15 percent for non-fossil fuels in its energy mix in the 13th five-year plan (Central Committee of the Communist Party of China, 2016), which it overshot, and increased its target for the 14th five-year plan to 20 percent (Central Committee of the Communist Party of China, 2021). However, through 'buying quota' for coal energy, and levies on or even direct shutdown of wind and solar generation capacity, the Chinese grid operator and provincial governments have propped otherwise uncompetitive coal plants (Mori, 2018). This led, for example, to seasonal curtailment of wind energy reaching up to a spectacular 60 percent of all generated wind power in certain provinces in 2016, albeit the curtailment rate declined precipitously in the following years due to mitigating measures (Zhu et al., 2019).

While the issue of overcapacity goes back over a decade, the decentralization of approval for new coal plants from Beijing to provincial governments in the period of 2014–2016 is widely acknowledged to have had a cataclysmic effect on the rise of coal-fired electricity capacity in China. Provincial governments propped up demand for local coal, looking to make regional employment and production targets. In less than a year, they collectively approved 210 new projects for 169 GW (Global Energy Monitor, 2019). Ren et al. (2021) find that the approval rate of new projects was three times higher when approval was decentralized, and that the increase was stronger in coal-producing regions. Many of the projects that have either entered construction phase or plan to do so in the coming two years, stem from this era.

Because of overcapacity issues, bankruptcies have surged in the coal-

[2] In the review process it became apparent that Springer et al. (forthcoming) have also applied the AOC-framework to the Chinese case. Springer et al. focus less on the relevance of the anti-graft campaign and more on the effect of the consolidation of state-owned enterprises. In addition, Springer et al. give more of an overview of historical policies and have not included an overview of types of policies that potentially play a role in a coal phaseout. This has led to complementary papers. Otherwise, their conclusions are mostly in line with those of this paper, in particular regarding the importance of the interplay between national and subnational levels of government and the poignancy of conflict over environmental issues for understanding climate policy.

[3] See for example *Global Energy Monitor, 2021* (2). See Manych et al. (2021) for applications of such databases to analyze global financial flows of coal plant financing.

fired electricity sector in the last two years (Xu and Patton, 2019). The national response focused on preventing ruptures in the market structure, looking to maintain large institutions by merging bad and good assets (State-owned Assets Supervision and Administration Commission of the State Council, 2019). In addition, the Chinese COVID-19 response has seen a renewed focus on employment and production. After a dip in demand for coal due to COVID-19, licensing for new plants rebounded strongly (Tullonen, 2020). On the June 18, 2020, the NDRC announced that it would support closure of older plants and the construction of new ones. Given overcapacity issues, the relatively young fleet of coal plants in China with an average age of only 15 years (Global Energy Monitor, 2019), and recent bankruptcies, it is beyond doubt that this is an inefficient avenue for a stimulus, even disregarding externalities such as climate, environmental and health costs.

3.1.3. Industrial market for coal

Coal, as noted above, is produced mainly in the three bordering center Northern provinces of Shanxi, Inner Mongolia and Shaanxi. China's industrial heartland is the coastal area that lies just to the southeast of those provinces. China's top three provinces for the production of crude steel, the largest industrial sector in China in terms of its demand for coal, are Hebei, Jiangsu and Shandong (National Bureau of Statistics of China, 2020). Perhaps not surprisingly, these are the coastal provinces closest to the heart of coal production – allowing for relatively cheap access to coal as well as exports by sea. Provinces in the same center-Eastern area are also among the largest producers of cement and various chemicals. The strongest increase in both output of coal and crude steel over the period of 2009–2018 was also in these very same provinces (Ibid). The economic ties between the coal producing and consuming sectors show that there is more at stake than the vested interests of the coal producing regions. Industrial sectors currently benefit from their access to relatively cheap and reliable coal as well as cheap and reliable electricity, and therefore have an interest in the continuation of coal production and coal-fired electricity production within China. Intersectoral linkages between coal production and energy-intensive consuming sectors such as steel, cement, chemicals, and textiles add further complications to China's managed coal phaseout. As the coal phaseout may raise energy costs for energy-intensive, trade-exposed industries in China, it may generate spillover unemployment in these coal-dependent industries. There will be differential impacts by province, as indicated in Table 1 and Fig. 2, and future research could further tease out which coal-reliant industries in which provinces will likely face the greatest transitional risk, perhaps requiring additional compensatory relief (as described in Section 5).

3.1.4. Coal labor force

Imperfect labor force mobility among China's coal workers further complicates efforts of the Chinese state to pursue an expedited coal phaseout. It should first be noted that the coal-related sectors (mining and electricity generation) have significantly higher average wages than other sectors such as manufacturing, construction, and agriculture (see Table 2).

However, beyond the wage disparities which likely predispose coal sector workers to prefer remaining in the industry, there are several countervailing forces which may lessen worker opposition to an expedited coal phaseout. First, as documented in Wright (2012), China's coal sector workers are predominantly of the older generation, many of them above the age of 40. This means that transitional compensation packages, such as those recommended in Section 5 of this paper, will not necessitate massive early retirement schemes if the coal phaseout is undertaken gradually over the next two decades, since a substantial fraction of the coal labor force will be retired by then anyway. In this case, the main challenge would be to prevent younger workers from entering coal-related sectors. On this point, Wright notes that many families that lived through China's one-child policy remain reluctant to send their child to work in coal-related sectors, especially as miners, given the relatively high rates of worker fatalities due to mining accidents. Wright also raises the broader issue of worker precarity in the Chinese coal industry (which is greater than, for example, analogous risks in the renewable energy industry), given the repeated cancellation of coal construction projects and the Chinese coal sector's heavy reliance on a rural immigrant workforce which lacks basic organizing rights. Lastly, it is noteworthy that not all workers in coal-related industries will necessarily struggle to find alternative employment. While miners are likely to struggle from transitional unemployment due to a general lack of transferable skills, other coal sector workers may be well-placed to apply their skills in different industries such as IT, finance, and the growing services sectors. Thus, while the growth rate of employment in China's renewable energy sector exceeds the (negative) growth in coal jobs, not all laid-off coal workers will need to rely on new employment in renewable energy sectors.

Table 1
China's top producing provinces for coal and crude steel.

Product	Top producing provinces in 2018	Strongest increase in production 2009–2018
Coal (100 million tons)	1. Inner Mongolia (9,76) 2. Shanxi (9,26) 3.Shaanxi (6,30)	1. Inner Mongolia (3,75) 2. Shaanxi (3,34) 3. Shanxi (3,32)
Crude steel (1 million tons)	1. Hebei (237,23) 2. Jiangsu (104,22) 3. Shandong (71,77)	1. Hebei (11,87) 2. Jiangsu (48,70) 3. Shanxi (27,38)

Note: Data is from China Statistical Yearbook, editions 2010 and 2019 (National Bureau of Statistics of China, 2020).

Fig. 2. The blue area consists of China's top coal producing provinces: Inner Mongolia, Shanxi, and Shaanxi. The orange area consists of its top crude steel producing provinces: Hebei, Jiangsu and Shandong. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

3.2. Policy formation process

In this section we will give a very broad outline of the *formal* policy formation process regarding energy and climate policy in China. Informal influence is discussed in more detail below in section 4.

3.2.1. Target setting in five-year plans

Energy policy, as a major aspect of economic policy, is a central part of each five-year-plan issued by the CCP. Policy targets at the highest level of abstraction are set in five-year plans. The process of drafting the

Table 2
Average annual income by sector and province (CNY/year).

	Coal-related sectors		Other sectors		
	Mining	Electricity production	Manufacturing	Construction	Agriculture
Inner Mongolia	120,107	101,391	75,457	54,811	54,445
Shanxi	81,324	87,122	57,348	60,309	45,934
Shaanxi	100,597	105,701	72,846	64,735	62,010
Shandong	96,161	107,732	69,354	66,282	66,884

Note: Data is from China Statistical Yearbook, 2019 edition (National Bureau of Statistics of China, 2020).

five-year-plan starts when the CCP's Central Committee comes together for a plenary session and issues 'recommendations'. These recommendations are very general and indicate directions rather than targets or goals. An example from the Central Committee's recommendations for the 13th Five-Year Plan: "China will (…) increase the proportion of non-fossil energy resources, and promote the clean and efficient use of fossil fuels such as coal" (Central Committee of the Communist Party of China, 2015).

The National Development and Reform Commission (NDRC), a ministerial-level body of government, is in charge of moving from these recommendations to a concrete five-year-plan. Input is gathered from other government bodies, both in Beijing and lower-level, academics, think-tanks and leaders of industry. The draft is also open to public consultation for a brief period. The NDRC-draft is presented to top-government officials, the premier, and finally to the leadership of the party. Notably, the Chinese climate department was moved from the NDRC to the Ministry of Ecology and Environment during a reorganization in 2019. This reduced the scope of influence for officials tasked with climate policy to influence the 14th Five-Year Plan, while at the same time consolidating the role of regulating the CO_2 emissions of the power sector in a new ministerial department tasked with managing China's nationwide carbon market which launched officially in 2021.

In the 14th five year plan, released in March 2021, the Chinese government reiterated its commitment to 'clean coal'. This was generally received as a sign that the announcement of Xi Jinping at the UN in September 2020 that China would become carbon neutral by 2060 and peak its emissions before 2030 should not be taken to mean that short-term stimulus of the economy through power-plant construction should suffer (Liu et al., 2021).

On the basis of this general five-year plan, more specific five-year plans are issued for each sector and also for several subsectors. The Five-Year Plan for energy policy is drafted by the National Energy Administration (NEA). It includes much more detailed targets, such as a reduction of the share of coal in primary energy consumption to below 58 per cent. In addition, the NEA drafts five-year plans for subsectors such as coal, renewable energy and natural gas. These will include broad outlines of policies that will be pursued to reach the targets.

3.2.2. Implementation in policies and laws

The goals and targets listed in the five-year plans are then put into laws, regulations, standards, plans and other forms of policy measures by ministries. In the case of energy policy, these tasks are divided over no less than eight different ministries (Nahm, 2020). The most relevant for coal policy, however, are the NEA and State-owned Assets Supervision and Administration Commission (SASAC). Laws drafted by these authorities are generally discussed three times by the Central Committee before they are put to parliament – which hardly ever rejects a bill. Lighter forms of policies, such as the setting of standards, fall under ministerial responsibility.

Implementation of policies are delegated to a large extent to provincial and local levels. An important feature of the decentralized implementation of Beijing's policies is that, in the absence of strong democratic and judicial checks and balances, local and provincial administrators are mostly responsive to the demands and perceptions of higher levels of government. The famed bureaucracy of China runs on an intricate system of incentives for decentral administrators. Meeting climate targets, along with achieving other policy objectives such as economic growth and limiting environmental degradation, can help an administrator move up the chain of command – but the success of this system in attaining policy goals that are not directly related to economic growth or employment is disputed. In section 4.2.1, we will take a closer look at this issue.

4. Actors, objectives, and means for attaining their objectives

4.1. Actors and their objectives

In this section, we ask the question: who holds a seat at the table in coal policy deliberation? There are several aspects of China's political economy of coal that are to be taken into account in answering this question.

Firstly, there are questions regarding the substantively relevant levels of policy-making. China is governed by five levels of administration: central, provincial, prefecture, county and township. All relevant capacities for oversight, licensing and policy making of the coal sector are either at the central or provincial levels of government. Coal mining, coal-fired power generation, and trade in coal all require permits and are conspicuous activities that are unlikely to go unnoticed by provincial governments on a scale that is significant to the sector as a whole. Therefore, it is safe to say that nearly all activities within the Chinese coal sector carry at least implicit approval of government, and at least at the provincial level. We will therefore limit our analysis to the central and provincial levels of decision-making.

At the provincial level of coal policy-making, political and commercial interests of course depend strongly on the characteristics of the provinces. A list of substantively relevant political actors therefore includes not only several bodies of national government, but also different types of provincial governments, clustered according to their shared objectives: there are the *coal-producing provinces, industrial provinces*, and *other provinces* which are generally net consumers of coal for electricity generation. This typology is limited in detail but includes the most vocal actors in coal policy-making within the universe of Chinese provincial governments.

Secondly, the political and non-political spheres are not clearly separated in China. As membership of the CCP is widely considered to be a precondition for any position of power within either government or large state-controlled companies — including nearly all large energy and industrial companies, as well as relevant parts of the financial sector —, standard typologies for actors within national political economies fail to apply to China. We therefore include state-owned enterprises (SOEs) in fossil fuels, SOEs in renewables, and grid operators as separate groups, rather than under the classifier of 'non-political actors' that is used by Jakob et al. in their paper. Similarly, the inclusion of voters or labor unions seems superfluous given their lack of effective power in the Chinese context.

An overview of the most relevant actors and their objectives is given in Table 3 below.

Table 3
Policy objectives of key stakeholders in China's coal sector.

Actor	Coal policy objectives
Central government	
President and party leadership	- Maintaining position within Chinese leadership and CCP - Maintaining employment and regionally balanced economic growth - Meeting climate change targets under Paris agreements
NDRC	- Strong and sustainable economic development on macro level within China - Support for, execution of, successive five-year plans
SASAC	- Financial health State Owned Enterprises
National Energy Administration	- Meeting energy-related goals and targets set by party leadership
Provincial governments	
Coal producing provinces	- Employment – stimulating domestic demand for Chinese coal - Safety and working conditions
Industrial provinces	- Employment, low energy prices, reliable supply
Other provinces	- Development - low energy prices, reliable supply - Local generation over import - Limiting environmental degradation
State-owned enterprises	
Mining companies	- Profitability – large domestic demand
Electricity companies, fossil-based	- Low costs of raw input - Room for expansion - raising caps and quotas for coal fired electricity - Maintaining favorable legal and fiscal regime
Electricity companies, renewables	- Changing legal and fiscal regime to suit needs carbon transition
Industrial companies	- Low costs of raw input
Grid operators	- Limiting costs for integration of relatively expansive renewables unto the grid (Mori, 2018) - Maximum utilization of grid - Maintaining monopoly position through centralized energy production

Note: the key policy objectives of each stakeholder are inferred based on official press releases, policy position briefs, media reporting featuring interviews, NGO reports and academic researchers specializing in Chinese energy policy. See in particular: Central Committee of the Communist Party of China (2015, 2016, 2021), Global Energy Monitor (2019, 2021), Li (2014), Myllyvirta et al. (2020), Nahm (2020), State-owned Assets Supervision and Administration Commission of the State Council (2019), Van der Kamp (2020), Ren et al. (2021), Wright (2012) Xu et al. (2019).

4.2. From objectives to outcomes: how does power flow between actors? Evidence from Chinese coal sector developments, 2010–2020

A catalogue of actors and their objectives does not, on its own, provide sufficient information to gauge possible and real-world policy outcomes. An important part of the context in which these actors will have to achieve their goals is formed by the relevant power dynamics. Assumptions about power dynamics are intrinsic to any discussion of strategies for policy change, but are often revealed in prospective policy assessments only implicitly. We suggest making these assumptions explicit, when possible in a standardized way, as this part of the analysis of any political economy is too substantively important to be shrouded by ambiguous statements regarding the 'context' of policy formation.

In Table 4 below, we suggest a generic framework for making assumptions about policy change explicit. In this framework, we separate power over the policy formation process (who determines taxes and laws) from power over physical outcomes (who determines whether and where the coal is mined or the power plant is constructed). Furthermore, we suggest partitioning this power into *direct* and *indirect* power, where indirect power runs through another actor. Lastly, we suggest making (assumptions about) the relevant power relationships to other actors that are involved explicit in the analysis.

It is important to note that Table 4, and particularly the last column, should be read as hypotheses of the authors that could explain the dynamics in the Chinese coal market as observed. Since decision-making in the Chinese coal sector is to a large extent opaque, the available method is to deduce power dynamics from coal sector developments. Our sources therefore consist of reports on power struggles that do reach the surface through official press releases[4] and media coverage,[5] as well as the academic literature as listed in our bibliography – in particular Bulman (2016), Doyon (2020), Myllyvirta et al. (2020), Nahm (2020), Van der Kamp (2020) and Wright (2012). We welcome any discussion on the hypotheses forwarded in Table 4, and recognize the necessity of improving our assumptions through open debate.

In the following section, we describe two of the most telling cases of the past decade (2011–2020): the continued rise in coal-fired power capacity, and Xi Jinping's famed anti-graft campaign with its focus on the energy-industrial complex.

4.2.1. Increasing coal-fired capacity: principal-agent problems, or imperfect commitment to climate targets?

In section 3.1.2, we demonstrated the rise of coal-fired capacity in China against the odds of both economic rationale and publicly stated central policy goals. Two explanations are logically feasible: either the central government has been insincere in setting its targets, or it has been incapable of achieving them. In this section we will argue that there is much stronger evidence for the second explanation: in spite of its high-capacity bureaucracy, Beijing has been unable to fully enforce its

[4] An exhaustive list of all press releases used would consist of many pages, but see for an example the releases cited in Zheng (2021) on the most recent actions in the anti-corruption campaign by the CCP in Inner Mongolia.

[5] Idem for journalistic work, but see for an example Martin (2014) on the relationship between the party leadership and the NDRC.

Table 4
Power that actors hold over policy formation and outcomes.

Actor	Power over policy and outcomes	Direct or indirect transmission	Hypothesized power relationships to other actors
Central government			
President and party leadership	Policy: makes political decisions on central policy	Direct	Direct control over NDRC, SASAC, NEA, both in content of policy and in appointments.
	Outcomes: strong influence over actions state-owned companies	Indirect (via boards companies)	Control over appointments state-owned companies, control via (threats of) changes to policy
NDRC	Policy: advises and drafts economic policy proposals	Direct	Advisory role to party leadership, drafts 5-year-plans and yearly policy on economic reform
SASAC	Policy/outcomes: oversees and makes policies regarding state owned companies, controls part of companies	Both direct and indirect (via company leadership)	Investor, manager and/or supervisor towards central SOEs. Advisor to party leadership.
National Energy Administration	Policy: maintains traffic light system, (dis) allowing permitting coal plants	Direct	National Energy Administration has been significant target of anti-graft campaign, showing power struggle within Beijing
	Outcomes: central supervision of execution policy	Indirect (via provincial government)	Imperfect grasp of permitting practices by provincial government
Provincial governments			
Coal producing provinces	Policy: consulted in formulating mining policy	Indirect (via central government)	Tied to central government via performance based incentive structures, but e.g. managed to curb concentration efforts over past 15 years
	Outcomes: executive powers towards operating mines, including licensing	Direct	Anti-graft campaigns shows levels of entanglement – most likely significant regulatory capture
	Outcomes: close relations to mining companies	Indirect (via leadership mining companies)	Interchange of high-level executives common between regional governments and mining companies.
Industrial provinces	Policy: consulted in formulating energy and industrial policy	Indirect (via central government)	Tied to central government via performance based incentive structures
	Outcomes: executive powers towards factories and coals plants, including licensing	Direct	Anti-graft campaigns shows levels of entanglement – most likely significant regulatory capture
	Outcomes: close relations to industrial and energy companies	Indirect (via leadership energy and industrial companies)	Interchange of high-level executives common between regional governments and mining companies
Other provinces	Outcomes: executive powers towards coal plants, including licensing	Direct	Anti-graft campaign shows degrees of entanglement – most likely significant regulatory capture – coal plant expansion in spite of policy efforts of the central government.
	Outcomes: close relations to energy companies	Indirect (via leadership energy companies)	Interchange of high-level executives common between regional governments and mining companies.
State-owned Enterprises			
Coal mining companies, and coal-dependent electric utilities and industrial companies	Outcomes: investment decisions, company operations	Direct	Permitting necessary, dependent on quota system, but significant regulatory capture
	Policy: through informal ties and close relations	Indirect (via provincial and central governments)	Input considered significant in the five-year planning process
Electric utilities and independent power producers - renewables	Outcomes: investment decisions, company operations	Direct	Permitting necessary, dependent on quotas, currently publicly dissatisfied (and in judicial procedures on) relationship with provincial governments and state grid operator
State grid operator	Policy: through lobbying	Indirect	Significant lobbying power, seen for example in efforts at limiting wind power regulatory system (Davidson et al., 2017)
	Outcomes: monopoly on buying from producers and selling to consumers, grid management	Direct	Limited power through strict quota system; however, significant influence on quota system through lobbying

will on the coal sector. Principal-agent problems, prevalent throughout Chinese environmental and climate policy, are the main cause: the interests of those that implement policies do not always align with the intentions of policy makers in Beijing.

Principal-agent problems occur in all large, centrally administered nation-states, but are particularly problematic for Chinese political leaders (compared to, say, the United States) because Beijing is heavily dependent on direct, top-down control over the lower echelons of bureaucracy to execute its plans. In absence of democratic accountability and a judiciary with sufficient power to check provincial and local authorities, the Chinese state has relied on incentivizing bureaucrats directly (through monetary rewards or promises of promotion) to comply with national policy goals (Van der Kamp, 2020). This approach has been highly successful in achieving a high rate of economic growth with a large degree of decentralized executive power. However, as Van der Kamp (2020) convincingly demonstrates, this approach has been unsuccessful in achieving full compliance with national environmental policy goals: incentivizing local officials to fully meet targets for the reduction of air-pollution, for example, has proven elusive. This misalignment of incentives has been damaging to the enforcement of a

range of policy goals that do not result in short-term economic growth (Nahm, 2020). As a result, direct control from Beijing (often lacking in their allowance for nuance in local circumstances) has taken the form of "blunt force regulation" (Van der Kamp, 2020).

The licensing of new coal plant projects in the period 2014–2016, described above in section 3.1.2, demonstrates how principal-agent problems govern the coal-sector in China. After coal plant approval was decentralized, approval rates increased threefold. The effect was particularly strong in coal-producing regions, suggesting that vested interests had a considerable influence over local politics. Beijing quickly reacted, and reversed the decentralization. The National Energy Administration implemented a traffic light system in 2017, communicating in clear terms where permitting was allowed and where it was not. In addition, Beijing put a halt to a massive 169.5 GW of coal plants that were already planned or under construction.

However, the incentive structures within Chinese governmental and (state-owned) commercial institutions prevented these policies from fully bearing fruit. The Chinese central government announced in 2016 that limiting the overcapacity in the Chinese coal sector could mean the loss of 1.3 million jobs in the coal sector, along with 500.000 jobs in the steel sector, resulting from limiting overcapacity there (Yao and Meng, 2016). As the incentive structures for provincial officials continue to favor short-term economic goals over climate and environmental considerations, provincial governments were not incentivized to take on their share of these job losses, but instead to continue their policies of attracting investment within their borders to create short-term stimulus. As a result, satellite data showed that in 2019 nearly half of the 169.5 GW of coal plant development put on halt, was under active development or being commissioned (Global Energy Monitor, 2019). It is unclear to what extent central authorities were able to monitor and control this development, but given the size of coal plants it is clear that provincial governments cannot have been unaware of new coal plant construction. In net terms, China added 42.9 GW of coal plant capacity to its grid in 2018 and the first half of 2019, against central policies and against macroeconomic logic (Global Energy Monitor, 2019). The growth rate increased in 2020 (Global Energy Monitor, 2021). For reference, the rest of the world on net decreased coal plant capacity over the same period, by decommissioning more capacity than was commissioned.

It is clear incentives for provincial officials do not always align with the intentions of central government. This is not to hypothesize that the commitment of the central state to its climate goals is perfect; most likely, as is the case with many western governments, the central state contains competing factions representing competing interests (Joas et al., 2016). Even when the state manages to speak with one voice, publicly stated long term targets are not always backed by sufficient short-term policy actions, especially where those policies might harm specific interests. An example is the curtailment of renewables from the grid – one of the measures by provincial governments and the State Grid Corporation of China to prop uncompetitive coal plants. The Chinese state has intervened to limit the blocking of renewables from the grid, for example by setting a minimum percentage of electricity on the grid to be sourced from renewables, but has stopped short of legislation that prevents curtailment everywhere – a measure that would be well within its reach (Mori, 2018). However, out of the two rival explanations of imperfect commitment and principal agent problems, the latter seems to carry significantly more weight towards explaining the continued rise of coal power in China.

4.2.2. Ties between industry and government: from communal interests to corruption

Close ties between leading figures in the energy sector, industrial sectors and politics are common around the world. In China, state-owned enterprises (SOEs) dominate the energy and industrial sectors. Companies that are to some extent owned by central or decentral governments control 90 percent of generating capacity in the Chinese electricity market (Oxford Institute for Energy Studies, 2020). This means that these sectors are not only strongly linked to politics through informal links and lobbying groups, but also directly, through ties of management and ownership. The ties for central, non-financial SOEs mostly run though SASAC. It appoints board members, has to approve of all major strategic decisions and drafts legislation that directly concerns state-owned enterprises. This gives the Chinese state a more direct control over outcomes in the energy and industrial sectors than most other states have.

Another feature of the exceptionally close ties between the state and the industrial and energy sectors is the interchange of leading personnel. Again, such close ties are hardly exclusive to China, but the SOE-system as well as the firm grip of the CCP over appointees in non-state companies do make these ties in China exceptionally close. It is commonly understood that at least CCP- membership, and, more preferably, a CCP-career, is a necessity for high office in large companies. At the national level, this high level of entanglement can be witnessed in the careers of men (almost exclusively men) such as Xiao Yaqing. Xiao Yaqing is currently a member of the 19th Central Committee of the CCP as well as the director of SASAC. Between 2004 and 2009, he served as Chairman of the Aluminum Corporation of China. Examples at the provincial level include Chen Derong, General Manager of Baosteel Group, former vice-governor of the central-coastal province of Zhejiang. But perhaps the most telling case for the purposes of this article is that of Wang Xiaolin. After a 20-year career at Shenhua Group, China's largest coal conglomerate, he took on the position of head of the NEA in 2015. In 2018, he was arrested on corruption charges.

Given the high level of entanglement, corruption is a serious threat to the energy-industrial-political system. Xi Jinping's anti-corruption push of the earlier years of his chairmanship was focused in part on weeding out this bog of mixed interests. In 2013, then Deputy Director of the NDRC Liu Tienan, became one of the first targets of the anti-graft campaign. He is currently serving a life-sentence in prison. Since the start of the campaign, no less than twelve senior-level officials of the NEA have been arrested for corruption. Among them were two directors and two deputy-directors (Meng and Chen, 2018).

The focus of the anti-graft campaign on corruption in the energy- and, in particular, the coal-sector has not been limited to Beijing's inner circles. The coal-province of Shanxi has borne the brunt of the campaign, with no less than 15,450 officials arrested in 2014 alone, mostly related to the coal sector (Ibid). According to a database keeping track up until 2018, four out of the top-five provinces with the most high-level corruption arrests were located in the north-eastern heartland of coal (ChinaFile, 2018). One of the most debated corruption rumors of the decade was the alleged existence of a 'Xishan society' – a group of businessmen and officials from Shanxi province that met in the Western hills of Beijing to discuss how to further their mutual interests (Li, 2014).

It is safe to conclude that corruption and the anti-graft campaign have played a significant part both in central and provincial politics of coal. While distinguishing motives in the anti-graft campaign is not straightforward, and mapping the rivaling cliques vying for coal-power is not within the scope of this paper, this continuing struggle is evidence of the contentious relationship between the central policy-setters in Beijing, and decentral energy sector powers. This fits our hypothesis that the central government is not lacking in commitment, but lacking in control to curb the expansion of coal and meet climate targets.

5. Policy toolkits

In the previous sections, we have described recent developments in the Chinese coal sector and who holds power in determining the future of the coal sector in China. In this section, we will provide a policy toolkit for a coal phaseout. The toolkit consists of two parts. The first part is aimed narrowly and directly at phasing out coal from the energy system - by agreement, via the market or by law. The second part of this toolkit is aimed at the secondary policy goals of compensating affected

parties, in order to make the necessary policy steps more palatable (and thereby also more likely). For the second toolkit, we make grateful use of previous work by Spencer et al. (2018).

5.1. Toolkit for a coal phaseout

Firstly, we will focus on the policies that have the narrow aim of phasing out coal from the entire energy system. We note that none of the policy options below are revolutionary new ways of tackling the problem – all of these options have been used in the transition away from coal or for other climate policies, several of them in China and others abroad. This makes it all the more surprising that no systematic overview of these policies has been given. Collier and Venables (2014) provide an overview of policies specifically aimed at coal mining, but to the best of our knowledge such an overview for climate-based coal policy does not exist. We note, secondly, that many of the same policy options apply to other challenges in the energy system related to climate change.

Ultimately, the set of policy options to achieve the goal of moving away from coal dependency in energy supply is limited. There are:

1) 'Command-and-control' instruments: varieties of prohibiting coal-fired installations and/or obliging alternatives, either now or in the future;
2) Market based instruments: varieties of raising price of coal-based production and/or lowering price of alternatives, either now or in the future; and
3) Agreements, information and expectation based instruments: varieties of pushing consensus and focus attention of relevant actors away from coal and/or towards alternative low-carbon energy sources.

In Table 5 below, we provide a systematic overview of these policies, as well as the countries where they have been applied.

5.2. Toolkit for compensation policies: relieving systemic stress from coal phaseout

As Jakob et al. (2020) note accurately, there are many common policy goals that interfere with the policy goal of mitigating climate change, such as employment and economic growth. As the effects of a transition away from coal on these policy goals are felt by concentrated and organized groups, these policy goals often receive undue prioritization - undue from the perspective of social optimal outcomes. If these groups can be compensated, however, this problem can be overcome.

The main groups that can be targeted by compensation are owners of capital, laborers and regionally defined communities. Compensation to these groups can smooth over opposition from vested interests. Depending on the target and form of compensation, additional policy goals can be achieved. Compensating owners of capital, for example, can stabilize investment climates. Compensating laborers through educational programs, on the other hand, can help achieve other labor market goals, such as reducing shortages in specific sectors.

An overview of the different forms of compensation is present in Table 6 below.

5.3. Suggested policy mix for a Chinese coal phaseout

In this section we will compare the policy toolkits of sections 5.1 and 5.2 to policies that have been implemented in China since 2010. Tables 7 and 8 summarize the findings. From these tables, two main conclusions follow: much has been done in terms of energy policy on the national scale, but little has been achieved in terms of setting the right incentives. These conclusions reinforce those drawn in sections 3 and 4: although macro-economically coal investments are not attractive compared to alternatives, the incentive structure for those that hold power over investment outcomes leads to continued investment.

Table 5
Policy toolkit for phaseout of coal emissions.

Type of policy	Policy option	Varieties	Countries of application[a]
Command and control	– Prohibiting the burning of coal for energy generation by law or setting standards to that effect	1) Either now or at some point in the future. 2) Only for electricity generation or for both heat and electricity.	– Canada, Netherlands, UK, Germany, Finland
	– Prohibiting building new installations for coal-fired energy supply or coal-fired industrial production.	1) Either now or at some point in the future. 2) Only for electricity generation or for both heat and electricity. 3) Only in sectors in which cost-effective (or cost-efficient) alternatives are available;	– UK, Canada, Israel, New Zealand, several EU-countries (including France and Germany)
	– Obliging the application of alternatives (for example: renewable obligations)	1) Obligation on lower governments or private companies. 2) Levels of incentives to comply with obligations (economic, legal, etc.) 3) Tradable certificates or fixed obligations	– EU towards member states, UK and Chile towards producers
	– Direct governmental investment away from coal and/or in alternatives.	1) Through fully nationalized companies. 2) As shareholder in SOEs. 3) In infrastructure (e.g. grids)	– Practiced widely around the world, including China
Market based instruments	– Emission trading systems	– Either through cap & trade systems, or through baseline and credit systems	– China, EU, South-Korea
	– Direct pricing or price floors	– Differences in tax base: on emissions, on coal or fossil fuels generally, or differential energy taxation	– Varieties of energy and fossil fuel taxes around the world
	– Subsidies for (innovations[b] in) alternatives or efficiency	1) Feed-in-tariffs. 2) Investment subsidies 3) Exploitation subsidies 4) Lowering cost of capital	– Implemented widely, examples include Germany (feed-in tariff) and Norway (sovereign fund)
Agreements, information and expectation based instruments	– Agreements with energy companies about phaseout	1) Agreements on years of shutdown 2) Agreements on new investments 3) Agreements on maximum emissions or efficiency (energy or carbon)	– Several EU states including Germany, UK, several US states including Washington
	– Setting targets and ambitions	1) Targets for coal phaseout 2) Targets for decarbonization that are sufficiently stringent to limit coal	– Practiced almost universally

(*continued on next page*)

Table 5 (*continued*)

Type of policy	Policy option	Varieties	Countries of application[a]
		3) Targets for renewables	
	– Knowledge-sharing to raise public awareness	1) Information campaigns 2) Guarantee of origin-schemes	– Practiced almost universally

Note: Toolkit for coal emissions phaseout based in part on the analysis in Oei et al. (2019).

[a] Only countries where policies have been implemented since 2010 have been included. The list of countries per policies below are not exhaustive, but are examples of where such policies have been implemented. Information on countries is derived from Galgóczi (2019) for Austria, Germany, Spain and France, from Hubbard and Núñez (2016) for Washington State, from Nacke (2020), for Slovakia, Greece, Finland, Spain, Canada and Germany, and from direct governmental sources for the Netherlands. These are merely examples known to the authors; undoubtedly more countries have the same or similar policies.

[b] Innovation policy is not under all circumstances a market based instrument; if viable technological alternatives are not readily available, for example, the first objective of an innovation policy is to *create* an alternative rather than lowering the price. Given the state of the art in renewable energy generation, however, the aim of innovation policies in the coal phaseout is to lower the price of alternatives.

Firstly, China has implemented a variety of policies on the national level to curb the growth of coal. It has tried to do so with a set of command-and-control type policies, such as provincial-level restrictions on permitting and quotas. In addition, market-based solutions, such as its own cap-and-trade system and subsidies for renewables, have helped reduce the profitability of coal vis-á-vis alternatives. These policies have been accompanied by a clear agenda and precise targets on a national level. Direct agreements with companies have not been made, but are also unnecessary given the ownership structure of large energy companies and the strong role of the state. While more can be done, particularly in the field of electricity market reform (Robinson and Li, 2017), given the limited effects of previous reforms and the already bleak long-term economic outlook for the Chinese coal sector it is unlikely that further reducing economic prospects will be the most efficient avenue for achieving coal phaseout.

Secondly, the Chinese state has by comparison made little effort to compensate those that stand to lose from a coal phaseout. It has recognized the necessity of mitigating the effects of reducing overcapacity in the coal sector on its labor force, allocating 100 billion yuan to relocate workers in 2016 (Yao and Meng, 2016), but few other examples of compensation mechanisms are known to the authors. In part, the effects of a coal phaseout are mitigated by the ownership structure in the Chinese energy sector, with large conglomerates able to shift workers from one production site to another, and even from one sector to another. But it is also likely that a lack of judicial and democratic pressure leads to limited compensation. The introduction of compensation mechanisms, especially at the provincial and company level, could help resolve the incentive problems in the Chinese coal sector.

6. Conclusion and policy implications: sensitive intervention points for a Chinese coal phaseout

Limiting China's coal expansion should be on the top of the global climate agenda. Given the magnitude of the vested commercial and political interests involved, many observers have doubted the pliability of China's coal-dependent, export-oriented manufacturing economy, as some energy system forecasts indicate that the prolongation of coal-fired electricity capacity in major Chinese provinces is not a mere short-term inconsistency with the central government's climate policy but an indication of the country's long-term priorities, which continue to privilege economic output over environmental protection. Our analysis has indicated how big steps towards a Chinese coal phaseout can be taken with minimal harm to public or private interests, and at negative social costs.

Table 6
Compensatory policy options for a managed coal phaseout.

Target group	Policy option	Additional policy goals	Countries of application[a]
Laborers	– Direct monetary compensation	– Equality of wealth	– Alberta (CA)
	– Providing training and/or transferring facilities for alternative employment	– Reducing labor market shortages in sectors	– Germany, Austria, Italy, Alberta (CA), Spain
	– Early retirement schemes	– Reducing youth unemployment	– Germany, Austria, Italy, Spain, Slovakia
Owners of capital	– Direct monetary compensation	– Maintaining/ improving investment climate	– Spain, Slovakia, Alberta (CA), Germany
	– Conversion into alternative productive asset (e.g. biomass electricity plants, repurposing disused mines)	– Renewable energy production, maintaining/ improving investment climate	– France, Spain, Slovakia, Finland
	– Deals on policy framework until moment of closure	– Maintaining/ improving investment climate	– Washington State (US), Netherlands, Finland
	– Deals on governmental action towards other assets	– Maintaining/ improving investment climate	– Greece
Communities	– Monetary compensation through decentral governments	– Budget support to fiscally constrained regions	– Greece, Germany, Spain
	– Investments in economic structure and local employment	– Raising employment, Improving economic structure, e.g. infrastructure or renewable energy production	– Austria, France, Slovakia, Greece, Canada, Spain

[a] Only countries where policies have been implemented since 2010 have been included. The list of countries per policies below are not exhaustive, but are examples of where such policies have been implemented. Information on countries is derived from Galgóczi (2019) for Austria, Germany, Spain and France, from Hubbard and Núñez (2016) for Washington State, from Nacke (2020), for Slovakia, Greece, Finland, Spain, Canada and Germany, and from direct governmental sources for the Netherlands. These are merely examples known to the authors; undoubtedly more countries have the same or similar policies.

In section 3 we demonstrated the clear macroeconomic case for disinvestment from coal. In section 4, we presented the main actors, their incentives and the power structure that ties them. We argued that, although the central state is a henhouse of competing interests, there seems to have been a sincere albeit unsuccessful effort to curb the growth of coal by the most central policymakers. This effort has been unsuccessful because of the incentive structure for Chinese officials and the leadership of state-owned enterprises. While electricity market reform (Gallagher et al., 2019; Robinson and Li, 2017), the design of the Chinese Emission Trade System (Stoerk et al., 2019), and financial market reform targeting shadow banking (Łasak, 2015) have received much attention in the literature, market-based reforms will have limited efficacy if political incentives remain misaligned. In section 5, we showed that these conclusions are confirmed by observed policy outcomes. By compiling a toolkit of policies for a coal phaseout and mapping the Chinese policy mix over this toolkit, we have demonstrated

Table 7
Policy options for a managed coal phaseout.

Type of policy	Policy option	Application in China?
Command and control	– Prohibiting the burning of coal for energy generation by law or setting standards to that effect	– Not implemented
	– Prohibiting construction of new installations for coal-fired energy supply or coal-fired industrial production.	– Implemented for specific regions through traffic light system amongst other policies
	– Obliging the application of alternatives (for example: renewable obligations)	– Quota for minimum integration of renewables onto the grid
	– Direct governmental investment away from coal and/or in alternatives.	– Both direct investment in coal and in alternatives through state owned-companies
Market-based instruments	– Emission trading systems	– Cap-and-trade system part of the 13th five-year plan
	– Direct pricing or price floors	– Direct pricing for all forms of electricity generation
	– Subsidies for (innovations in) alternatives or efficiency	– Substantial efforts in building renewable production industry in China, direct subsidies to renewable production
Agreements, information and expectation based instruments	– Agreements with energy companies about phaseout	– Not implemented, most likely in part because of direct ownership
	– Setting targets and ambitions	– Clear targets including caps for coal development and carbon peak/reduction
	– Knowledge-sharing	– Close interactions between academics, state-run companies
	– Public awareness	– Not implemented

Table 8
Compensatory policy options for China's managed coal phaseout and their implementation status.

Target groups	Policy option	Implemented in China?
Laborers	– Direct monetary compensation	– Not implemented
	– Providing training and/or transferring facilities for alternative employment	– 100 billion yuan scheme launched to this effect in 2016
	– Early retirement schemes	– Not implemented
Owners of capital	– Direct monetary compensation	– Often state-owned companies
	– Conversion into alternative productive asset (e.g. biomass electricity plants, repurposing disused mines)	– Not occurring to the best of our knowledge
	– Deals on policy framework until moment of closure	– No public deals to such effect
	– Deals on governmental action towards other assets	– No public deals to such effect
Communities	– Monetary compensation through decentral governments	– Not occurring to the best of our knowledge
	– Investments in economic structure and local employment	– Not occurring to the best of our knowledge

that, on the one hand, much has been done in terms of first-order energy and economic policy, but, on the other, there is an almost complete lack of policies compensating vested interests for disinvestments from coal.

This leads us to conclude that substantial progress towards climate change mitigation and China's 2060 "carbon neutrality" target can be achieved with relatively minor policy changes targeting the following two "sensitive intervention points" (Farmer et al., 2019): (i) changing promotional criteria for party officials, and (ii) establishing compensation schemes for provinces and companies transitioning away from coal.

6.1. Setting promotional incentives for party officials in line with climate goals

As described in section 4.2.1, the Chinese system of promotional incentives for party cadres is geared more towards stimulating economic growth than it is towards environmental goals. Yet the promotional system is neither stagnant nor homogenous: evidence has suggested that under Xi Jinping's leadership the link between growth and promotion has weakened (Doyon, 2018), and that in some provinces security indicators are deemed more important than economic ones (Bulman, 2016).

We suggest that the single most effective measure a committed central government in China could take is to issue a set of clear-cut environmental indicators that will be taken into account in promotional considerations. The indicators could be based on, for example, the carbon intensity of provincial economies (in keeping with the target of the 14th Five-Year Plan to reduce the carbon intensity of the national economy by 18 percent), or on the collective provincial performance under China's Emissions Trading System (which has been suggested to be an information-gathering instrument more than a direct price setter). If provincial cadres start factoring in such measures in the same way as they have incorporated economic growth targets in their policies over past decades, this will be a major step towards a national coal phaseout.

6.2. Creating compensation mechanisms at provincial and company levels

Apart from individual bureaucrats, there are others that are not incentivized to work towards a transition away from coal. Coal companies, related industries, and laborers are prone to suffer from the transition. Considering the macroeconomic and social benefits of a transition away from coal, it would be sensible to ascertain whether part of the benefits can be used to compensate those that lose out.

Rather than invest in coal capacity, the Chinese state could use part of its income from SOEs to set up a fund that compensates communities and companies that either close down facilities or forgo planned expansion. Applications to such a fund could be made under strict requirements, such as the specification of concrete plans to retrain workers, the organization of alternative employment opportunities through investments in affected regions, and plans to replace forgone coal-fired electricity with electricity produced from renewable energy sources, together with concomitant investments in battery storage and transmission infrastructure. Perverse incentives could be attenuated by opening the fund only for a limited amount of time (e.g., for four years) and by requiring applicants to have had at least a provincial permit at the time of annunciation in the case of planned capacity, or to be at least 15 years old in the case of existent capacity.

Our analysis has adumbrated a politically pragmatic and, we believe, credible approach to resolving the internal contradictions of China's coal policy and climate commitments. The evidence reviewed has led us to an important, politically timely conclusion: if the central government moves decisively to alter the promotional criteria for party officials to incorporate robust indicators of decarbonization and progress towards climate mitigation targets, and if such changes are complemented with generous compensation mechanisms provided by central authorities to ease the transition away from coal at the provincial and company levels, China can single-handedly make relatively minor changes that drastically reorient itself—and the world—onto a development path consistent with the ambitious climate change mitigation commitments under the Paris Agreement.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

Bas Heerma van Voss: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing. **Ryan Rafaty:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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