Decarbonizing the Dragon:
Policy Communities and the Power of Networks

By

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ABSTRACT

What explains countries' policy trajectory to climate mitigation? How do state-society relations shape China's domestic energy policy? How do individual policy actors and interest groups influence policy formulation in authoritarian regimes? How do U.S.-China relations affect international climate cooperation? To answer these questions, I reexamine the climate policymaking process in China.

Conventional scholarship approaches China's policymaking through the lens of fragmented authoritarianism. However, as in most societies, policymakers in China often engage in networks of social relations involving various stakeholders and social actors. I contend that the structure of policy networks offers policy entrepreneurs a platform for connecting with and attempting to influence decision-makers. This conceptualization of authoritarian governance reconciles insights from scholars who emphasize informational, infrastructural, and autonomous aspects of policymaking, offering a micro-level foundation for a state-led governance system.

To operationalize this concept, I conduct a policy network analysis using original event-based network data from the central policy community in Beijing's energy and climate policy arena between 2014 and 2019. I find that state-society linkages shape state agencies' knowledge and policy preferences, which in turn determine the government's willingness to provide public goods.

At the policy implementation stage, the diversity of policy networks in which decision makers are embedded contributes to compliance and effective policy delivery because heterogeneous connections provide them with more information and alternatives for securing political support. I test this argument by examining local governments' preferences for renewable energy development in China. Drawing on original data on local policymakers' networks, I show that local governments are more likely to comply with the central government's goal for renewable development when policymakers are embedded in pluralistic policy networks. I estimate the causal effect of network diversity by leveraging wind speed as an instrument, because intermittent wind speed that causes renewable curtailment encourages stakeholders from different sectors to engage in networking activities. I also employ a quasi-experimental design and qualitative interviews to explore the mechanisms of engagement. My findings emphasize the structure of embeddedness and draw attention to how policy actors can leverage structural positions within the network to advance their policy agenda.

Internationally, I find that climate governance can serve as an anchor for cooperation between the United States and China to prevent further confrontation. For China, striking a climate deal helped usher in a new area of cooperation to avoid costly decoupling and geopolitical competition with the U.S.

Chapter 1
Decarbonization with a Coal Addiction

Introduction

Decarbonizing China's energy system, the world's largest national greenhouse gas emitter and coal consumer, is a top priority issue for a global energy transition. While its coal consumption has recently reached a plateau, China has committed to fueling its future development with low- carbon sources and achieving carbon neutrality by 2060. This means it will integrate more clean energy into its energy system and gradually phase out coal and other fossil fuels. Since 2006, China has initiated a series of energy and climate policies that have successfully helped cultivate a robust clean energy industry. Its investment in renewables grew by 100 times compared to 2005 and accounts for over 30% of global investments in renewable energy as of 2022. As a result, China's non-fossil fuel energy consumption increased rapidly, representing nearly 16% of its total energy consumption in 2020. While China's approach successfully facilitated a competitive wind and solar industry, which made it the front-runner in renewable installations and generation, its decarbonization path is shadowed by significant nation-wide renewable curtailment[1] and over-investment in coal-powered capacy. Despite serious renewable energy curtailment, the

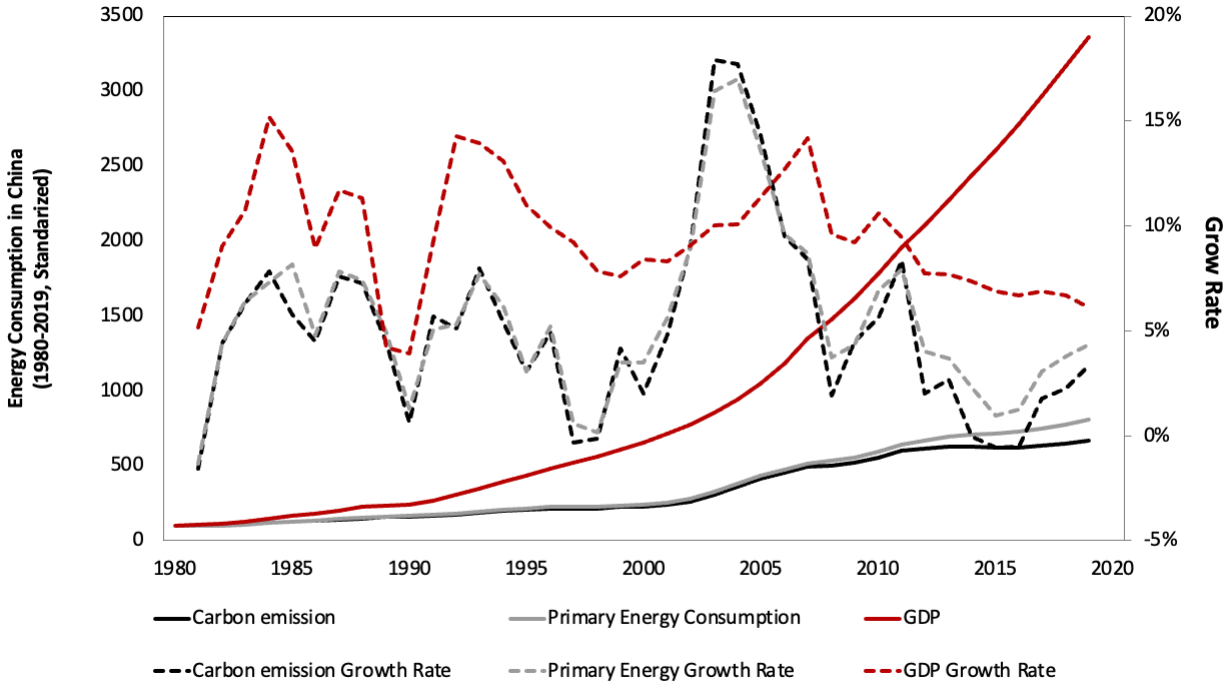
[1] Renewable energy curtailment refers to the practice of reducing the output of renewable energy sources, typically wind and solar power, below what they could otherwise produce given available resources, i.e., wind and sunshine. This can occur for a variety of reasons, most often due to grid reliability concerns or transmission congestion.

slowdown of electricity demand, and diminishing market prospects, China's investment in coal electricity surged so much that it accounts for 90% of the global total as of 2022. In other words, China is wasting carbon-free renewables while adding additional carbon-intensive, inflexible coal units into its energy system. What explains this puzzling policy outcome? How do we assess the success and failure of China's energy transition? What do such contradictory policy outcomes tell us about the policymaking process in China, and in authoritarian regimes in general?

Historically, China's economic growth was fueled by coal. In the age of fossil fuel, for a country with 97% of its fossil fuel resources coming from coal, it was the only safe and feasible fuel option for China to power its growth. Therefore, as China's economy averaged double-digit growth from 1981 to 2010, over the same period, coal consumption rose from 1.36 billion tons to nearly 4 billion tons, at an average annual rate of 12%. The carbon-intensive construction and manufacturing industry has been the engine of the nation's economic growth since economic reform. The high growth corresponds to rapid urbanization and industrialization driven by massive exporting. Despite gradual declines due to rising oil and hydropower consumption, coal still held a 70% share by 2010. At that time, decarbonization and climate mitigation were seen by the Chinese leadership as an economic slowdown and loss of competitiveness for China. Some scholars and China observers believed such concerns were the main drivers behind China's hostility toward international climate governance (Brenton, 2013; Terhalle and Depledge, 2013).

This logic continued to explain China's changing attitude toward decarbonization as its economic growth has slowed significantly since 2010 (Grubb et al., 2015). From 2011 to 2015, the GDP growth rate has been decreasing steadily, already the longest decline in contemporary China (see Figure 2). The five-year average of the growth from 2011 to 2015 is lower than any Five-Year-Plan (FYP) period since the economic reform in 1978. The growth rate in 2015 dropped to 6.9%, driven primarily by a slowdown in the heavy industry and construction industries. Through the course of 2015, coal use in thermometric power, iron and steel, and cement production decreased by 6.2%, 3.2%, and 8.2%, respectively. The slowed growth means less

Figure 1: GDP, Primary Energy Consumption, Carbon Emissions (making 1980 values as 100), and Their Growth Rate



Data source: Chinese Bureau of Statistics and BP Energy Statistics

pressure on demand for energy. The service and finance industry has indeed been growing fast, but its lower energy intensity (only one-quarter of the manufacturing industry) makes it a much lower amount of demand for energy. In other words, the economic "New Normal" is interpreted by experts to be that China's economy has decoupled from carbon-intensive sources, thus making it easier for China to comply with a more restrictive mitigation path.

Meanwhile, China's domestic energy and climate policy efforts have reinforced the trend of decarbonization. China has faced domestic and international pressures to reduce air pollution and mitigate global climate change. The 11th FYP (2006-2010) placed emphasis on the control of major air pollutants and greenhouse gases, mandating a decrease of sulfate and ozone emissions by 10% each and energy intensity by 20% over the subsequent five years. Decreasing coal use has been integral to meeting these goals, as coal combustion is the common source of most of the targeted pollutants and greenhouse gases. Furthermore, a cap on coal use has been set for ten eastern provinces. According to this policy, Beijing, Tianjin, Hebei and Shandong–which are big energy consuming hubs—are together required to cut their coal use by 63 million tons

from 2012 to 2017, a reduction equivalent to the total coal consumption of the UK.

In addition to energy efficiency and conservation, the rise of renewables provided feasible alternative energy for the energy transition. From 2004 to 2010, global renewable energy investment increased fivefold. Europe and the United States led the surge, representing more than 60% of the total investment over this period (Ajadi et al., 2020). During this period, Chinese renewable companies seized the booming demand in Western markets by rapidly scaling-up renewable manufacturing. Since 2011, however, renewable energy investment has slowed down significantly due to a sharp decline in European investment and a moderate cut from the United States. Their combined investments decreased by about 50% from 2011 to 2015, and the share of overall investment from developed countries decreased from nearly 80% in 2004 to 44% in 2016 (Ajadi et al., 2020). Meanwhile, the Chinese government recognized the importance of renewable energy, listing it in the *Made in China 2025* as one of the major drivers of the innovation-oriented economy. To make up for the demand drop in Europe and North America, China doubled its investment in the three years from 2010 to 2013, upholding global clean energy investment. Riding the high tide of clean energy development, China has successfully supported the renewables industry in terms of both installation and equipment manufacturing. Renewable energy, a key part of China's national strategy to combat climate change and air pollution, has grown by over 100 times since China passed its first renewable energy law in 2006 and accounts for over 30% of global investments in renewable energy today (IRENA, 2021). As a result, China's renewable energy consumption increased steadily over the past two decades, representing 16% of its total energy consumption in 2020, exceeding its Copenhagen climate pledge in 2008. Therefore, as shown in Figure 1 and Figure 2, China is experiencing a decarbonization rate driven mainly by renewable energy. Combined with the economic slowdown (and thus reduced energy demand), a cheap and strong renewable energy industry provides China with the necessary tools to adopt progressive international climate pledges. In late 2020, Chinese President Xi Jinping updated China's climate target under the Paris Agreement and committed to carbon neutrality by 2060, which is only 10 years after Europe.

In China, air pollution and climate change are generally understood as two related, but dif-

ferent issues. According to a recent survey on Chinese public opinion on climate change [2], over 94% of respondents believed that climate change is happening, and around 74% are willing to pay for climate actions. While this degree of support for climate action might seem high, particularly in comparison to sentiments prevalent in the United States, it falls short when compared to the Chinese public's overwhelming support for measures to combat air pollution, which stands at a remarkable 97%. The stark contrast underscores the urgency and visibility of air pollution in daily life, whereas climate change is often perceived as a more abstract, long-term issue. This differential perception necessitates different strategies in policy communication and formulation for these two environmental issues.

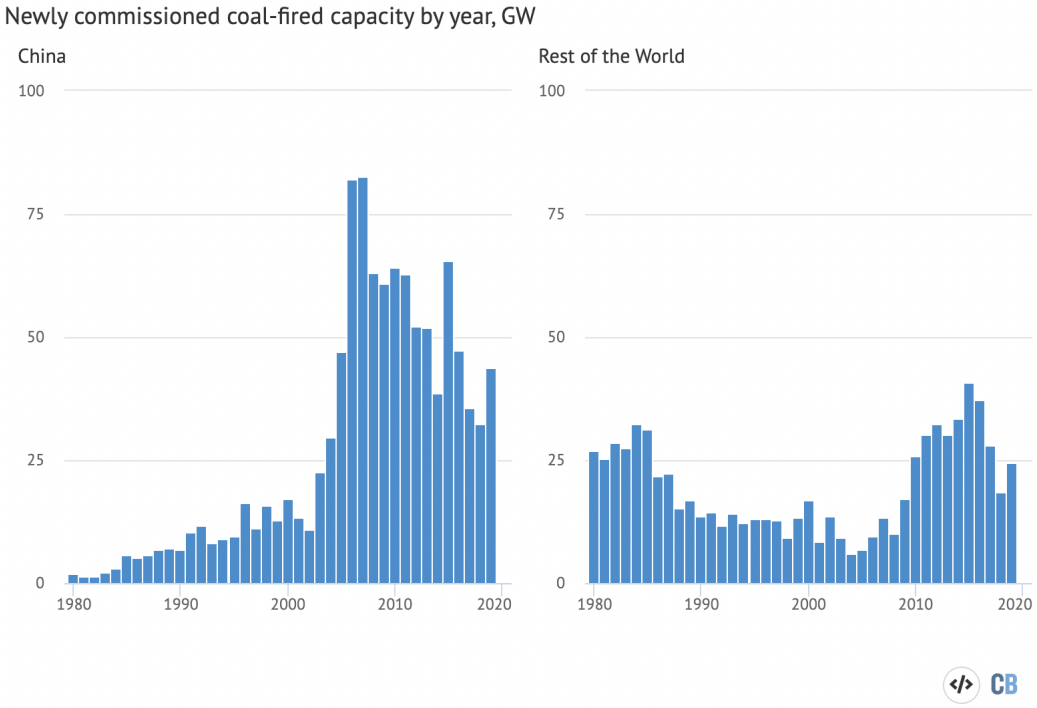
While renewable energy development presents a viable solution to both climate change and air pollution, China's policy responses to these two issues exhibit distinctive differences. From the perspective of the Chinese government, air pollution represents a more immediate threat, thus triggering more direct, command-and-control-based strategies. The government has enacted a multitude of regulations aimed at reducing air pollution emissions, some of the most significant being policies focused on sporadic coal and agricultural residue burning, manufacturing production control, and an initiative known as 'shang da ya xiao', which translates to replacing smaller, inefficient coal power plants with larger, more efficient units. However, these command-and-control approaches often entail substantial economic costs. A notable example is the policy to reduce air pollution in Beijing, where the government prohibited sporadic coal consumption for heating in nearby rural areas, which constituted around 10 percent of total coal consumption. This policy replaced coal with natural gas (also known as 'mei gai qi') in these areas. While this significantly reduced air pollution levels during winter, it also increased the energy burden on rural residents. Contrastingly, China's approach to tackling climate change is more flexible and involves significant market-based elements. For example, in 2021, the Chinese government launched a nationwide carbon market covering nearly 40 percent of overall emissions. The Chinese government perceives climate change as a long-term challenge and relies on renewable energy innovation and deployment. The government actively supports and

[2]Energy Foundation China, *Climate Change in the Chinese Mind Survey Report 2017*, source: https://www.efchina.org/Reports-en/report-comms-20171108-en.

motivates renewable energy innovation, recognizing it as a pivotal strategy for achieving energy sector decarbonization. For instance, in China's national industry policy, *Made in China 2025*, renewable and new energy technology innovation is placed at the center of China's national strategy.

Yet, two contradicting phenomena affect China's decarbonization. First, curtailment of renewable electricity generation is becoming part of the "New Normal" as wind and solar installation expand across the country. By definition, renewable curtailment is "a reduction in the output of a generator from what it could otherwise produce given available resources (Bird et al., 2014)." In other words, it means that even though a renewable energy source could generate electricity (such as a wind turbine when the wind is blowing, or a solar panel on a sunny day), grid operators order it not to. This can occur when the grid system lacks the capacity to transmit the power to where it's needed, the demand is insufficient, or there is a lack of energy storage facilities like batteries. From 2010 to 2018, wind energy alone curtailed 215 million megawatt hours (MWh), or as much as 16 percent of overall wind generation. Hydro and solar power also experienced severe curtailment during the same period (Cui et al., 2020; Tang et al., 2018). Second, as shown in Figure 2, China's coal power plants have expanded rapidly since 2014. In 2015 alone, the Chinese government approved nearly 200 GW of new coal power capacity (Ren et al., 2019). Although the National Energy Bureau (NEA) quickly put a hold on some coal projects, China's total coal capacity grew by 255 GW from 2015 to 2020, equivalent to the total coal capacity of the United States. Most of these power plants consisted of large slow and inflexible coal-fired units that are fundamentally incompatible with an electricity system with high renewable penetration. The massive coal capacity expansion raises serious concerns about overcapacity and negative impacts on global decarbonization, because these facilities are expected to operate for another 25-30 years. Therefore, China's decarbonization path constitutes a puzzle: on the one hand, China is an active leader of global climate mitigation and facilitates fast decarbonization using renewable energy; on the other hand, China is the world's largest investor in coal power plants, which are expected to pollute global climate for another three decades. What explains this self-contradicting policy outcome? More generally, What do these contradictory policy outcomes tell us about governance in authoritarian

Figure 2: New Coal Power Plant Constriction, China vs. the World



Source: Carbon Brief

regimes? More broadly, what political factors matter for climate change?

Theory

Authoritarian regimes are usually characterized by highly concentrated power, lack of accountability or institutionalized deliberation systems, and overreliance on coercion and elite cooptation (Acemoglu and Robinson, 2006; Boix and Svolik, 2013; Przeworski et al., 2000; Svolik, 2013). Therefore, policy-making in authoritarian regimes is often deemed unidirectional, arbitrary, non-transparent, serving the interests of authoritarian leaders and their allies (Bueno De Mesquita et al., 2005; Svolik, 2013), and variations or deviations at the local level are described as bureaucratic fragmentation (e.g. Lieberthal and Oksenberg (1988)) and elite politics or fractional struggle (e.g. Jiang (2018)).

Literature that focuses on policymaking in Western democracies, especially the United States, has long been paying attention to diverse aspects of policy formation and implemen-

tation (Baumgartner and Jones, 2002), emphasizing the role of interest groups (Baumgartner et al., 2009; Skocpol and Hertel-Fernandez, 2016; Stokes, 2020; Yackee and Yackee, 2006), the policy community (Huber and Arceneaux, 2007; Jacques et al., 2008), and the dynamic interactions between formal and informal institutions (Baumgartner and Leech, 1998; Skocpol et al., 2000).

In comparison, the literature on China's policymaking focus on political survival and fragmentation under authoritarianism. Therefore, my research question is pertinent to two strands of public policy and political science literature. The first strand addresses the concept of political survival, in which the longevity of authoritarian regimes depends on the rulers' successfully co-opting elites. From this perspective, policies are understood as a tool for cooptation and compromise, and policy outcomes are reflections of the struggles among, and the power structure of, political factions and interest groups (Jiang, 2018; Jiang and Zeng, 2020; Steinberg and Shih, 2012; Truex, 2020; Wang, 2016, 2018). The second and the most popular strand highlights the negative policy implications of fragmented authoritarian government in China's political system by emphasizing the cleavages, such as interest conflicts, power struggles, deviation and divergence, within the vertical and horizontal bureaucratic structure (Cai and Aoyama, 2018; Lieberthal and Oksenberg, 1988; Lieberthal, 1992; Mertha, 2009). From this literature, I develop four potential theories to explain the puzzle.

International prestige and domestic economic growth

Existing explanations have typically argued that an international climate treaty is adopted by countries driven primarily by domestic political and economic interests. These explanations are found in most works on China's attitude toward international climate regimes. It was believed that China is hostile to international climate treaties because they threaten the carbon-intensive development path (Christoff, 2010; Conrad, 2012). For a country with 97% of its fossil fuel endowment being coal, it was the only safe and feasible fuel option for China to power its growth. Therefore, as China's economy averaged double-digit growth from 1981 to 2010, over

the same period, coal consumption rose from 1.36 billion tons to nearly 4 billion tons, at an average annual rate of 12%. The carbon-intensive construction and manufacturing industry has been the engine of the nation's economic growth since the economic reform (Stern et al., 2011). Its growth rate averaged 12.6% from 1991 to 2010. The high growth corresponds to rapid urbanization and industrialization driven by massive exporting (Zhu and Peng, 2012). Despite gradual declines owing to rising oil and hydropower consumption, it still accounted for a 70% share by 2010. For China, decarbonization and mitigation were understood as economic slowdown and loss of competitiveness. Some scholars and China observers believe that such concerns are the main drivers behind China's hostility toward a binding emissions cap (Cheng et al., 2016; Hilton and Kerr, 2017; Zhou et al., 2021).

At COP15 in Copenhagen, China refused to make any binding commitment to combating climate change, claiming that developed countries, instead of developing countries, are the ones responsible for current climate issues. In the several years following the COP15, China's position remained the same: insisting that it has the right to development and no obligations for current climate change issues as a developing country and never committing to absolute emissions control. The international community, especially Europe and the United States, strongly criticized China for obstructing the negotiations and ignoring its obligation to the fate of humanity as the world's largest carbon emitter (Qi and Wu, 2013). Western climate negotiators called the Chinese negotiators "Mr. No" for their firm rejections of Western proposals.

This firm position took a sudden turn in 2014 when China and the United States surprised the world by signing the Joint Announcement on Climate Change and Clean Energy during President Obama's visit to Beijing for the APEC Summit. In the announcement, China committed to peak its carbon emissions around 2030 and increase its share of non-fossil fuel use to 20 percent of the total primary energy consumption by 2030. One major reason for its importance is that China, for the first time, committed to a target of absolute emissions control, something that developed countries have pushed for years. In the year leading up to the Paris Conference, China signed bilateral and multilateral announcements on climate change and clean energy with major countries around the world, including Brazil, France, Germany,

Russia, India, and the United Kingdom. Eventually, these announcements were institutionalized in the Paris Agreement as a politically binding international treaty. Many see China's efforts and leadership as the main driver of the success of the Paris Agreement (Christoff, 2016; Eckersley, 2020).

Since 2017, however, China's climate ambition has taken a sharp turn. Chinese provinces invested a significant amount in coal-electricity capacity construction (Yuan et al., 2016), announcing more than 200 new coal electricity projects with a total capacity of 225 GW, equivalent to the entire coal capacity of the United States. The resurgence of coal power plants has seriously threatened China's mitigation potential and its ability to fulfill its climate pledge. Some international observers believe that China is either under serious economic pressure to boost government spending or is disingenuous about climate change in the first place. In other words, China's climate actions are merely for window-dressing purposes. Following this argument, I posit an *international prestige hypothesis:*

Hypothesis 1: *China actively participated in global climate governance to bolster its international prestige.*

Political survival and policy-making as a tool of elite co-optation

The political science literature, especially that on authoritarian politics, often employs the logic of political survival when explaining policy outcomes. Many scholars assert that autocrats implement policies to buy support from domestic political actors who have the power to remove them from office (Bueno De Mesquita et al., 2005; Gandhi and Przeworski, 2006; Reuter and Robertson, 2015; Steinberg and Shih, 2012). For Chinese leaders in the central government, this means they must act carefully to limit the negative effects of energy and climate policy on the members of the selectorate, which includes powerful state-owned enterprises (SOEs) in the fossil fuel and heavy industries, as well as high ranking party elites who head ministries or provinces relying on the coal industry.

The same logic also applies to leaders in the sub-national governments. For provincial and

sub-provincial leaders, in order to win support from their selectorate, which consists of local industries, private business, and their immediate superiors, they favor policies that benefit local industries and short-term economic growth, because their political careers depend partially on the economic development in their jurisdictions (Cai and Treisman, 2005; Jiang, 2018; Li and Zhou, 2005). Only those politicians who have connections with a powerful patron are capable of fully implementing central policies or reforms, because their patrons can protect them from the backlash of local interest groups (Jiang and Zeng, 2020). Therefore, local officials' policy choices are subject to the influence of their political connections (Eaton and Kostka, 2017; Jiang and Zeng, 2020; Wang, 2016) and local interest capture (Hou, 2019; Steinberg and Shih, 2012; Wang, 2018). In sum, considering that local energy groups are more powerful where there are large coal endowments, the logic of political survival predicts sub-national officials' career incentives: they implement policies that promote renewable energy to better align with the goals of the central government (Cao et al., 2016), and approve coal projects to please local fossil fuel interest groups. Thus, based on political survival theory, I develop an *interest distribution hypothesis:*

Hypothesis 2: *China's energy policy reflects the geographic distribution of local energy interest groups. Provinces that have greater coal endowments will invest more in coal power plants.*

If the theory is correct, then I expect to see coal-heavy provinces favor coal power projects instead of renewables. In Chinese politics, elites who are referred to as the "oil gang," "coal gang," and "hydro gang" are some of the most powerful interest groups. The government must use policy concessions and distribution of rent to co-opt potential elite opposition. It seems unlikely that the ruling fraction would promote a small renewable industry that challenges the fossil fuel industry. Even if the central leadership is willing to do so, in theory, the fossil fuel interest groups should have enough resources and influence to undermine such efforts by threatening to destabilize the economy or even the political order. In this case, relying on coal would be an easier path than exploring other forms of energy because coal-fired growth does not challenge existing interest groups, it would not require new investment in energy

technology and infrastructure, nor would it need improvement in energy governance or further state capacity building.

Fragmented authoritarianism and central-local relations

The Chinese political system is heavily decentralized. Regional and local officials and non-government players are allowed to insert substantial autonomy and influence in the policy process. Some China experts thus developed the idea of fragmented authoritarianism. In their edited volume, Lieberthal and Lampton (1992) point out that the authority of the Chinese government is highly fragmented and decentralized. Provincial and municipal governments have considerable autonomy in terms of decision-making and economic planning, and thus create significant variations and sometimes deviations from the policy goals of the central government. Unlike a unitary hierarchical system, China's decentralized governance system relies both on vertical authority or top-down command and control (*tiao* or string), and horizontal relationships among different governmental organizations (*kuai* or block) (Cai and Aoyama, 2018; Lieberthal and Oksenberg, 1988; Mertha, 2009). At the central level, consensus building and informal bargaining between multiple departments are necessary for policy-making and implementation (Lieberthal and Oksenberg, 1988); at the local level, officials engage in collusive behavior and selectively implement central government policies, and therefore create considerable deviation from the intended outcomes of the higher-level government. From the central-local relations perspective, while the central government dictates national policy-making, it lacks the necessary information and capacity to customize detail-oriented policies that account for all local specific political and socioeconomic factors. Therefore, local governments rely heavily on *kuai* relationships for policy implementation, adopting and adjusting higher-level policies to local specific conditions and aligning the incentives of local actors with policy objectives.

Some other scholars categorize the decentralized aspect of the Chinese political system as "quasi-federalism" or "Chinese style federalism." Montinola et al. (1995) argue that the decen-

tralized political structure preserves necessary incentives and flexibility for sub-national governments to carry out market-oriented policies, contributing to the success of China's economic reform. Jin et al. (2005) emphasize that the quasi-federalist government structure provides a competitive environment for local government to pursue economic and other reforms. The decentralized nature is one of the sources of China's state capacity for policy and institutional innovations, allowing the party-state to quickly adjust and adapt to complex regional and international market environment (Heilmann, 2008). Such 'laboratory of the local governments,' Cao et al. (1999) argue, functionally resembles the federalism in the United States.

Although the quasi-federalist political structure provides considerable flexibility that allows local officials to address local challenges, the fragmented governance system creates gridlock and deviations from national policy goals, which eventually challenge China's policy effectiveness and authoritarian rule (Lieberthal and Oksenberg, 1988). O'Brien and Li (1999) argue that the incentive mechanisms in the cadre evaluation system encourage local government officials to selectively implement the central government's policies, prioritizing those clearly defined or quantifiable targets and binding targets that have veto power (such as GDP growth and social stability), while ignoring vague, unquantifiable or nonbinding policies (such as sustainable development). Zhou (2017) finds that lower-level officials often engage in bargaining with their superiors about their performance evaluation and form alliances with each other to compromise the original intention behind state policies during the implementation process. Especially in areas that require collaboration and coordination among multiple government agencies across different regions, decentralized settings encourage local protectionism, inefficiencies (sometimes gridlock), and non-compliance with central regulations (Mertha, 2005). To overcome these drawbacks, the central government relies on various political mobilizations and campaigns for policy realignment and re-centralization, even though doing so would retrospectively discourage policy flexibility and adaptability for providing local development (Mertha, 2005; Zhou, 2017).

The fragmented authoritarian framework successfully identifies the paradoxes embedded deeply in the authoritarian political regime governing a giant and highly diverse country: the

central government faces the tradeoffs between pursuing goals of economic development, often relying on the local initiative, versus environmental and climate sustainability, usually facilitated by a top-down and centralized approach. Therefore, over thirty years after the birth of the theory, many scholars are still using the fragmented authoritarian framework to explain China's renewable energy curtailment (Cai and Aoyama, 2018; Qi et al., 2019), inconsistencies in energy and climate policies (Liu, 2019; Marks, 2010), inefficiencies in renewable investment (Shen and Xie, 2018), contradicting sustainable development patterns (Green and Kryman, 2014), as well as alternating centralization-and-decentralization of policies (Alkon and Wong, 2020; Kostka and Nahm, 2017). Building on the existing studies, I have developed the *fragmented energy governance hypothesis:*

Hypothesis 3: *Because of pushback from local interests, the central government is unable to enforce its climate and energy policy implementation across all regions.*

Thus far, the literature is overwhelmingly state-centric, and actors outside the government arena are severely understudied. As China's economy develops into a more diverse and mature one, other non-government actors, including SOEs, the private sector, NGOs, the media, and other social actors, become more involved in the policy process, at least in some areas. Even though the Chinese state still exploits fragmented authoritarianism, the policy process and policy network have grown more complicated. Acknowledging the limits of the "central vs. local" dichotomy, some scholars turn their attention to individual actors and their dynamic interactions that create deviations in policy implementation. Mertha (2009) identifies three types of policy entrepreneurs in the policy process: government officials, the media, and NGOs. He argues that these policy entrepreneurs explore the opportunities in the fragmented bureaucratic system and seek potential supporters for new ideas and issue frames. Cai and Aoyama (2018) assert that even though bureaucratic fragmentation hinders policy changes, it also serves as an opportunity for local policy entrepreneurs, allowing them to engage with stakeholders and build coalitions, which eventually help to break the gridlock and accommodate local interests. Teets (2013) uses the term "consultative authoritarianism" to describe this more interactive model of the relationship the state and civil society.

Even with these modifications, the fragmented authoritarian framework falls short in at least three aspects. First, mere presence in the policy network does not guarantee policy influence. Second, fragmentation does not necessarily lead to interest diversification. Local interests are usually defined by local government and non-governmental actors, who are vertically and horizontally connected with regional and national players. These connections might retrospectively shape the local interest structure. Third, even though fragmentation explains policy deviations, it is insufficient in explaining policy formation, especially for those policies requiring substantial expertise beyond the knowledge of professional bureaucrats. As the country develops, the expert knowledge required for governing increases exponentially. Complex climate and energy systems, for instance, impose severe challenges to governance because of their high levels of connectivity, nonlinear patterns of change, dynamic and directional processes, and emergent properties and frequency of surprises (Young, 2017). Such knowledge and expertise are clearly far beyond the reach of ordinary bureaucrats. Therefore, while fragmented authoritarianism provides a useful theoretical framework, it overlooks many key players in the policymaking process.

Network influence in authoritarian regimes

The aforementioned studies have contributed tremendously to the scholarly understanding of many aspects of authoritarian policy formation in China. Despite their essential theoretical contributions, some of this literature is built on an abstract picture of reality that ignores important micro-level dynamics. In fact, China's policymaking involves substantive deliberative empowerment (Li, 2017). The existing literature on China's policymaking has identified a number of potentially influential factors for final policy outcomes, but the actual process by which policy decisions get made and implemented still largely remains a black box. I argue that this is because many researchers, especially those from the political science discipline, sometimes underestimate the level of complexity and deliberation involved in policymaking and thus oversimplify as if it is a closed, cohesive, and arbitrary process.

Scholars in American politics have been paying attention to different phrases in the policy process. Arnold (1992) emphasizes that policy enactment is an important stage in which policymakers evaluate the political consequences of the policy, taking into account both the preferences of potential winners and losers. Utilizing the enactment process that is categorized by ambiguity, uncertainty, and unintended consequences, interest groups, advocates, and other actors estimate the political implications of the policy and then strategically engage in intensive negotiations, cooperation, and compromises with one another (Arnold, 1992; Bergquist, 2020; Stokes, 2020; Stone, 2012). After the policies are implemented, the interest groups can better update their information and work more intensively to adjust their strategies in dealing with the new policies Stokes (2020). Here, I adopt the definition used by Dryzek et al. (2013), which categorizes deliberation as *'communication that is non-coercive, capable of connecting expression of particular interests or positions to more general principles, induces reflection on the part of those both speaking and hearing, in which participants strive to make sense to those who do not share their own conceptual framework' (p.12).* The deliberative influence has an independent effect on policy outcomes in the absence of structural changes in political power.

The existing literature includes multiple theoretical expectations about what an authoritarian regime should look like: authoritarian policy is a measure of interest distribution among elites in exchange for political support; the authoritarian policy-making process is top-down or hierarchical because these regimes lack checks on power and space for bottom-up approaches; authoritarian policy considers public demand due to the threat of elite rebellion rather than the power of persuasion. These expectations become presumptions that guide scholars in a specific direction as they try to explain phenomena in an authoritarian country. For many political scientists, authoritarianism is, theoretically, consequently characterized by power concentration and exclusive decision-making; many scholars are naturally drawn to the central state and the ruling coalition in the study of almost any political matter in China. Elements and dynamics outside of those state- and elite-centered ones are seen at best as trivial, if they ever exist.

The strict but largely arbitrary dichotomy between "autocracies" and "democracies" further guides scholars away from factors identified as important determinants of policy formation

in democratic settings, such as the policymaking processes in legislatures (Lü et al., 2020; Williamson and Magaloni, 2020), policy networks (Duckett, 2019; Shen, 2017; Zheng et al., 2010), and policy communities in the society (Mertha, 2009; Teets, 2018). In fact, just like any other complex and highly diversified economy, China's policies reflect diversified socio-economic and political interests. Only very recently have several researchers begun to notice these factors, and their studies have contributed critically to bridging gaps in the literature, showing the great value in studying these niches that are common to policymaking in different institutional contexts.

Recent literature on policymaking in China finds that policy networks play an important role as a vehicle for deliberation. Gallagher and Xuan (2019) state that non-governmental expert advisors are involved in the formal decision-making process by directly submitting suggestions to or sitting on the advisory boards of government agencies. Other economic and social actors, including SOEs (Wang, 2018), private business (Hou, 2019; Wang, 2016), NGOs (Anderson et al., 2019; Mertha, 2009; Teets, 2018) all play an important role in the policy process. Duckett (2019) finds that even international policy actors work through policy networks and international organizations to influence decision-making in China. This is particularly true for climate change policy because it is also an international hot topic. Some international climate actors, such as Lord Nicholas Stern, a long-time climate advocate, have a close relationship with top Chinese policy actors and party leaders. Even in China's legislature, in the "two sections," which are commonly categorized as rubber stamps, policy actors engage in intensive coalition building to advance their policy agenda (Lu and Nemet, 2020).

Therefore, to better understand policy outcomes, we must investigate the origin of policy ideas, where and how elites and interest groups exert their influence, and how their interactions with decisionmakers affect policy. Building on micro-level analysis, my last two hypotheses provide a more comprehensive understanding of policy networks in authoritarian regimes by answering the following questions: Who are the participants in the policy process? To what extent does their participation influence policy outcomes? I argue that China's seemingly self-contradictory decarbonization pattern reflects intricate dynamics and interactions between var-

ious policy actors in different stages of the policy process. I argue that deliberative influence is prevalent in the stage of policy enactment. Policy networks are more diversified at the central level, with scholars and experts possessing higher centrality. International policy entrepreneurs have a strong connection with domestic policy actors who have strong centrality and thus can also influence China's climate policy agenda via policy networks. The structure of the policy network provides policy entrepreneurs with a platform through which individuals connect and attempt to influence decision-makers in a subtle and indirect way. This theoretical framework generates three observable implications:

Hypothesis 4: *The diversity of policy networks at the central level is associated with support for green energy and climate governance.*

Here, by network diversity, I contend that China's policy network involves experts and policy entrepreneurs from various backgrounds, including academics, NGOs, private businesses, SOEs, government officials, and representation from other social groups. Unlike H1, the Chinese government recognizes climate change as a critical challenge because the policy entrepreneurs were able to convince the decisionmakers of the important value of climate change for long-term economic development, political stability, and international prestige.

Hypothesis 5: *The presence of international policy entrepreneurs in the central policy network is associated with stronger government support for green energy and climate governance.*

Given the global nature of climate change, coupled with China's position as the world's largest carbon emitter, international stakeholders are particularly focused on China's role in this issue. Many international climate entrepreneurs are actively cultivating robust relationships with their Chinese counterparts to promote mutual cooperation and learning in the climate change arena. Through strategic networking, international actors are given a platform to share their ideas, best practices, and recommendations, which can shape and influence China's policy agenda. Not only does this provide them with an opportunity to bring global perspectives to the table, but it also allows for a more holistic approach in addressing climate change. By introducing diverse perspectives and solutions into the Chinese policy-making process, these

international actors play a crucial role in fostering collaboration, encouraging policy innovation, and ultimately driving forward China's commitment to sustainability and climate action.

This hypothesis is not to say that interest politics do not matter to the policy process, or that Chinese policies are strictly meritocratic; rather, I seek to explain how diverse voices are introduced into the policy process, especially at the central level. In fact, interest groups could also utilize their networks to exert influence on policy enactment and policy implementation. For instance, experts from the energy industry routinely serve as consultants to government regulators and participate in the policy process. The National Energy Administration and local government rely heavily on the grid experts for assistance on industrial policy and electricity planning, opening up opportunities for the State Grid Company to influence government actions. Exploiting the fragmented bureaucratic system, the energy industry utilizes its monopoly over technology expertise for policy retrenchment, pushing back electricity market reforms and restructuring.

I also argue that *in the policy implementation stage, interest groups work through policy networks to push for policy retrenchment.* In a centralized political system, the central government has much greater resources at its disposal, resulting in an unequal distribution of deliberative capacity between the provincial and the central government. Therefore, climate policy retrenchment is more likely to work at the local level, where the interest groups of the fossil fuel industry have a stronger influence.

Building on Pierson (1994) and Stokes (2020), I define policy retrenchment as a policy change that undermines the main orientation of the policy. I show that the interest groups can retrench policies in both direct and in indirect ways through displacement, layering, drift and conversion (Mahoney et al., 2010). In China's decarbonization case, I contend that the fossil fuel industry is likely using one or more of these strategies to uphold coal investment. Therefore, if deliberation influences policy outcomes via networks, the specific policy outcome can be attributed to the structure of the network:

Hypothesis 6: *At the provincial level, the diversity of interest groups in the local policy network is associated with stronger support for renewable energy; the higher the diversity, the*

higher the share of renewable generation capacity.

In Chinese authoritarian regimes with a weak accountability system, bureaucrats are responsible for policy development. Even though pluralistic policy networks also introduce multiple stakeholders with veto power, I argue that diverse policy networks can facilitate the government's capability to promote policy goals. A diversified network creates a competitive environment that involves multiple stakeholders, and weakens the influence of powerful coal interest groups. By involving multiple stakeholders, government policymakers could extract *alternative political support* for implementing central-government policy, and gather *more complete information and policy ideas* in a specific governance arena. This argument builds on two assumptions: that a policy actor in the network represents the interest of a specific sector, which is associated with their professional affiliation, and that their objective is to affect government policies to advance the interests of their own sector.

This revised hypothesis builds upon Hypothesis 2, addressing its limitations at both the local and central levels. Hypothesis 2 fails to explain why non-coal-producing provinces and those with a strong focus on renewable energy also invest in coal projects. Additionally, it does not account for the Chinese government's initial investment in the renewable industry or its commitment to climate mitigation. These hypotheses complement the existing macro-level fragmentation and political survival theory by providing a comprehensive micro-level foundation. It elucidates the mechanisms through which diverse actors influence policymaking within an authoritarian context, offering a clearer and cohesive understanding of the process.

Structure of Dissertation

Departing from the tradition that focuses on formal institutions in policymaking, I emphasized the network influence in climate policy and analyzed how state-social linkages determine policy formation in the authoritarian regime. My dissertation is comprised of six chapters. This introductory chapter summarized the global decarbonization trend and introduces the puzzling policy outcome and difficulties facing China's energy transition. I also developed a theory

of authoritarian governance. I argued that even under an authoritarian regime, deliberative influence is prevalent in the policymaking process and has an independent effect on policy outcomes in the absence of structural changes in political power, whereas the fossil fuel interest groups work through their policy networks at the local level to push for policy retrenchment. Together, the deliberative influence at the central level and policy retrenchment at the local level explained the contradicting policy outcome in China.

Chapter 2 situates China's decarbonization efforts within the global context. I introduce a novel indicator, the Decarbonization Index (DCI), for evaluating worldwide decarbonization progress. I assess the historical energy transitions in Europe, the United States, China, and India using the DCI. I find that China's decarbonization progress is considerably faster than industrialized countries because it skips the oil and gas age by directly replacing coal with clean energy. I also apply the DCI for projecting the future of decarbonization in 15 countries, with the combined carbon emissions exceeding 95% of the world's total. Even though China is making significant progress compared to other countries, the business-as-usual path, however, is not enough to deliver its climate pledge on time. A significant boost for decarbonization will be needed after 2030. Additional policy tools, such as a carbon tax, a hydrogen energy plan, and higher subsidies for storage and carbon capture technologies are necessary for China to achieve carbon neutrality by 2060.

Chapter 3 examines China's commitment to global climate mitigation through the lens of great power competition. I find that domestic fossil fuel interest groups have minimal involvement in China's international climate strategy decision-making. Instead, US-China relations played a crucial role in elevating climate change's importance in China's international strategy. I argue that managing tensions with the United States by cultivating a cooperative climate is essential in understanding China's proactive role in climate governance. Using process tracing and interviews with key decision-makers, I demonstrate that striking a climate deal helped Beijing usher in a sustainable area of cooperation, which was done to avoid complete decoupling and geopolitical confrontation with the United States. Building a strong relationship with the West was a key motivation for China to continue to engage in international climate governance.

Therefore, zero-sum great power competition could put the fate of humanity in danger even without a hot war.

In the empirical sections on domestic Chinese climate policy, I employ a mixed-method approach. Chapter 4 utilizes network analysis to identify key players in the policy network and assess their influence on Beijing. I first identify key actors in the policy formation process, including government officials, state-owned enterprises, private businesses, NGOs, scholars, and international policy entrepreneurs. Next, I conduct interviews with major policy actors in Beijing and observe policy deliberation processes. Finally, I collect original data on individual policy actors, mapping their connections and interactions. This dataset, analyzed through network analysis, reveals core players and their interactions, shaping the formulation and outcomes of energy and climate policy. The network structure reflected the power dynamics among different actors. The diverse network in the central climate policymaking process in Beijing helps explain China's national policy for climate mitigation. I explore deliberative mechanisms and interest group influence on national-level climate and energy policy through two case studies: the 2015 Paris Agreement decision-making process and the 2020 carbon neutrality pledge. I find that non-government actors, especially academics and NGO activists, played a critical role in the policymaking process. Fossil fuel interests have limited influence in the policy network.

Furthermore, chapter 5 tests the hypotheses by exploring variations in the network structure at the provincial level. I gather network data from 26 provincial networks between 2015 and 2019. I then categorized the network based on the sectoral interest each individual (node) represents and measured the diversity of provincial policy networks across time and space. Subsequently, I conduct statistical analyses and estimate the causal effect of network diversity using a natural shock as an instrumental variable. These analyses demonstrate that interest groups, such as the State Grid, coal industry, and electricity companies, are more active during the policy implementation stage at the local level, seizing opportunities for policy retrenchment to their advantage. My findings suggest that, in the absence of a functioning accountability system, the network structure that bureaucrats are embedded in contributes to their autonomy against fossil fuel interest capture, thereby contributing to renewable development. China's decarbonization

process is not categorized by arbitrary decisionmaking and interest group capture; instead, the policymaking process reflects the intricate interactions between diverse actors that drive the policy outcomes. This study also shows that policy processes in authoritarian regime settings bear some similarities to those in democratic systems. It introduced a more flexible and evolving process of interest alignment to the concept of political survival, fragmentation, and the synergizing of interests.

Lastly, chapter 6 concludes by discussing the implications of networks in authoritarian regimes and their similarities with networks in democracies. By comparing with the network influence in the United States, my dissertation investigates how macro-structural factors translate into political power and national climate actions by analyzing micro-level policy networks. This approach is at the frontier of climate policy studies. Therefore, my research differs from most political science studies of authoritarian regimes, which understand policies as a tool for cooptation and compromise, and policy outcomes are reflections of the struggles among, and the power structure of, political fractions. Instead, I believe countries' decarbonization path reflects the fact that competing preferences and common grounds among stakeholders coexist in the policy arenas. It is their intricate interactions in different stages of the policymaking process that determines a state's capacity to deliver on its international goals. To the best of my knowledge, this is the first study to systematically identify the structure of and individuals in the climate policy community in China using social network analysis.

Chapter 2

Towards carbon neutrality: A new indicator to measure historical and projected energy transition

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Introduction

Phasing out carbon-based fossil energy is imperative to climate change mitigation. However, this goal did not appear in the agenda of United Nation Framework Convention on Climate Change (UNFCCC) until the 2015 Paris Agreement. First announced at the 2015 Group of Seven (G7) summit, the influential club of affluent countries aims to phase-out fossil fuels by the end of the century. This symbolic declaration means that developed economies once dependent on fossil fuel-fired growth are now explicitly committed to abolishing this historically indispensable ingredient of their prosperity. A few months later, the rest of the world echoed this aspiration by adding into the Paris Agreement the goal of net-zero emissions by the second half of the century. According to the most recent information from the Climate Ambition Alliance: Net Zero 2050, which was established at the 2019 UN Climate Action Summit, 1101 companies, 549 research and educational organizations, 45 financial institutions, 22 regions, 452 cities, and 120 national states are among the participants in this alliance calling for carbon neutrality in 2050. In the form of law, policy positions and submissions to the UN, more than 40 nations or regions have explicitly set carbon neutrality objectives.

The existing accumulative Nationally Determined Contributions (NDC) pledges, however, will be insufficient for meeting the net-zero goal (Allen et al., 2022; Handayani et al., 2022; Rogelj et al., 2021). Far-reaching national policies of the largest players may become triggers and even fundamental factors that shape the future of the social-natural systems in which we live, particularly in a time with a multitude of political, social, economic, and physical uncertainties (Den Elzen et al., 2019; Pan et al., 2020). How to measure the efforts of countries to achieve the goals of the Paris Agreement and NDCs, thus, has become a focus and hot issue in recent years.

The gap in 2030 between emission levels under full implementation of conditional NDCs and those consistent with least-cost pathways to the 2-degree target is 13 $GtCO_2e$. If only the unconditional NDCs are implemented, the gap increases to 15 $GtCO_2e$. It can be seen from scholars' scientific research (Rogelj et al., 2016; Schleussner et al., 2016) or IPCC's report on the realization of the Paris agreement (1.5-degree report) that there is still a large gap between the behaviors of countries around the world and the realization of the Paris agreement. Therefore, it requires stronger policy intervention to achieve the goal of 2°C (Huang et al., 2021; Olabi et al., 2022; Salvia et al., 2021; Wang et al., 2019).

The Paris Agreement allows countries to submit their own nationally determined contributions (NDCs), and thereby follow their own schedule for gradual decarbonization. This decentralized approach promises countries the ability to define their climate pledges based on the measurements that best suit their socio-economic capacity and national interests. While such flexibility accommodates political differences and maximizes common ground, it also complicates standardization and progress tracking (Den Elzen et al., 2019; Laudari et al., 2021; Tørstad et al., 2020), imposing potentially significant uncertainties (Rogelj et al., 2016). To make full-decarbonization an achievable, measurable goal for the economy, policymakers will need a more direct and comprehensive indicator to assess the decarbonization progress and identify crucial moments for effective energy policy. Above all, the indicator should be situated in a historical context, in order to provide a non-arbitrary benchmark for progress (or lack thereof). In this chapter, we proposed such a metric, which we call the Decarbonization Index (DCI).

This chapter proceeds as the following. In section 2, we review and identify the pros and cons of some existing indicators. In section 3, we introduce the DCI for assessing global decarbonization. We then evaluate the DCI by applying the novel indicator for evaluating the history of energy transition in section 4 and projecting the future of trajectory of

decarbonization in major countries in section 5. We find that the worldwide concurrence of accelerating decarbonization is hardly a coincidence; rather it is a signal of some larger and deeper social-economic changes. In section 6, we evaluate existing climate policies developed by various countries using the DCI. Finally, we summarize our contributions, findings and implications in the conclusion section.

Existing indicators for energy transitions

The concept of energy transition originated from the book *The Energy Transition: Growth and Prosperity Without Oil and Uranium* (GIAE, 1982), which initially defined the energy transition as the shift from oil and uranium to renewable energy to manage environmental and security risk. By 2021, about 4800 articles on the energy transition have been published on peer-reviewed journals, and the concept of the energy transition has been adopted by literature on energy conservation, climate change, sustainability, green and low-carbon development (Williams and Doyon, 2019). However, a board definition of energy transition incorporates the impact of climate change. For instance, Smil (2010) defines energy transition as "the process of changing from one specific energy form to another." Podobnik (2006) proposed that energy transition is a process in which a new type of energy is applied to human consumption in large quantities through the discovery of new technologies and the acquisition of new energy. Lu and Nemet (2020) reviewed current definitions of energy transition and considered energy transition to be a paradigm shift of primary energy from carbon intensive fuels to cleaner energy. They pointed out that even though the previous energy transitions do not have a clear mitigation intension, a transition from coal to oil and gas since 1860s, and from oil and (later) gas to nuclear and renewables since 1950s does have a clear direction in terms of per unit carbon intensity. Since climate change has become the most pressing concern for energy transitions, in this chapter, we adopt a narrow definition of energy transition and consider the global energy transitions as a systematic shift of energy structure with a clear direction toward carbon neutrality.

Kaya based indicators

Concerning the climate aspects of energy transitions, many indicators are developed to describe a national or international energy system and its climate implications (Neofytou et al., 2020). Generally, they were applied to track national climate commitments, trace, and predict global emissions trends, and to identify drivers for climate change mitigation (IPCC, 2014). To ensure

political feasibility, the Paris Agreement welcomes all existing measurements for climate commitments, including energy intensity, emissions peak, absolute emissions mitigation and the share of non-carbon sources in primary energy consumption. At the aggregate level, energy consumption by sources is used to describe total energy consumption and provide structural information about the energy mix. Some countries have been using one of its sub-components, the share of non-fossil fuel energy, as their climate commitment indicator. However, such an indicator overlooks important differences among solid, liquid and gas fossil fuels, given the fact that they significantly diverge not only in scale of use and method of application, but also in carbon emissions per unit combustion.

The most popular indicator is the Kaya identity (Waggoner and Ausubel, 2002). The Kaya Identity considered carbon dioxide emissions as a product of four factors: population, GDP per capita, energy intensity (energy per GDP) and carbon intensity (emissions per unit of energy). Table 1 summarizes the basic expression and implications of key indicators. Scholars and policymakers use Kaya identities and relevant extensions to track national progress and estimate future mitigation paths (IPCC, 2014; Raupach et al., 2007; Peters et al., 2015). Kaya identities and popular extensions include carbon/energy intensity of GDP, carbon intensity of energy/fossil fuel, and CO2 emissions per capita and energy use per capita, each of which could help to identify the driving forces of emissions (Raupach et al. 2007). Although Kaya identities are widely accepted as key indicators of progress on climate commitments, each of these provides only indirect or partial information about full energy system decarbonization. More importantly, they lack information about the gap and progress towards decarbonization of a given energy system and its implications for climate change mitigation, making it unintuitive to assess the speed and policy effort on energy transition.

Table 1. Kaya based indicators for tracking climate commitments and their underlined information.

Type	**Indicator**	**Expressed information**
Emissions	Aggregate CO_2 emissions from energy consumption	Carbon footprint of energy use
Energy	Energy consumption by source	Energy structure, energy use
	Non-carbon/total energy	Share of non-fossil fuel in the energy structure
Intensity	Energy/GDP	Energy consumption per GDP
	CO_2/GDP	Carbon footprint of economic activity
	CO_2/energy	Carbon footprint of energy use

	CO_2/fossil fuel	Carbon footprint of fossil fuel use
Per-capita	Energy/pop	Average energy use
	CO_2/pop	Average carbon footprint

Aggregated Index

Some aggregated indicators have been used to assess course of energy transition from historical perspective. For instance, The Energy Transition Index, published by World Economic Forum (Neofytou et al., 2020; WEF, 2019), has focused on economic development and growth, environmental sustainability, energy security and access of near 120 countries. The ETI is a global index that tracks the performance of energy systems at the national level. As an aggregated index, the ETI also incorporates macroeconomic, institutional, social, and geopolitical factors that are valuable to policymaking in energy transitions. Energy Trilemma Index, established by World Energy Council (WEC, 2020), is also an index for assessing course of energy transition from three important dimensions of energy transitions: equity, security, and environmental sustainability, and ranks countries by accessing their capacity to successfully deliver sustainable energy transitions across all different dimensions (Khan et al., 2021; Marti and Puertas, 2022; Song et al., 2017; Šprajc et al., 2019; Zafeiratou and Spataru, 2018). Other influential indicators include Energy Architecture Performance Index from World Economic Forum and Accenture (Budiarso et al., 2015; Fu et al., 2021; WEF, 2017). Renewable indicators for Sustainable Energy (RISE) published by the World Bank (2020) evaluate policies on electricity access, clean cooking, renewable energy, and energy efficiency. This indicator relies on expert assessment on the policy efforts, providing annual update about the policy and institutional efforts by different countries across the world.

The aggregated indicators aim to enable a comprehensive understanding of the states of energy transitions and provide informative policy and investment insights for effective decision make. However, while the existing indexes highlight some important socio-economic and political aspects of energy transitions, such as energy security, they are not necessarily objectively quantifiable. Making the indexes more complex does not necessarily making them more objective or informative to policymakers, especially for the ones rely heavily on expert assessment. Thus, evaluating socio-economic and political aspects of energy transitions are subject to judgment biases. More importantly, these evaluation composite indices of energy

transition cannot be used to predict future energy transition scenarios, and there is still no comprehensive quantitative evaluation method and result for the development stage of energy transition and the difficulty of achieving long-term energy transition target in all countries.

The Decarbonization Index

To provide a more comprehensive understanding of changes in an energy system and its implications for climate change, we develop a new indicator called Decarbonization Index (DCI). This comprehensive indicator – incorporating both historical and international considerations – seeks to capture the fundamental elements of a given country's energy system and its aggregate progress towards decarbonization.

The logic behind the DCI lies in the chemical composition of energy sources. Anthropogenic carbon emissions come from deforestation and the combustion of solid, liquid, and gas fossil fuels, each varying in carbon composition. Compared to coal, oil and natural gas have less carbon content but higher energy density because they contain more hydrogen; needless to say, nuclear and renewable energy sources have much greater advantages over hydrocarbons in terms of climate change mitigation. Thus, an economy's carbon intensity is the highest when coal is the only fuel available, and lowest when all energy sources are nuclear or renewables. Using the carbon intensity of coal as the baseline, the DCI measures how much a country has shifted away from the single most carbon-intensive way of fueling its economy. In other words, the DCI contains information about the climate footprint of fuels – the only source of CO2 emissions from energy use – in energy carriers. The DCI of country i at time t can be stated as:

$$DCI_{it} = (CI_{icoal} - CI_{it})/CI_{icoal} \quad (1)$$

$$DCINCit = Cinct/Cit = Einct * CIicoalt / Eit * CIicoalt = Einct / Eit \quad (2)$$

$$DCIOGit = DCIit - DCINCit \quad (3)$$

where CI_{icoalt} denotes the carbon intensity of specific type of coal in country i, CI_{it} denotes the carbon intensity of energy in country i at time t. Since different types of coal (Anthracite, Bituminous, Sub-bituminous, Lignite) have different carbon content, CI_{icoalt} depends on the natural endowment and varies across different countries. C_{inct} denotes the carbon emissions reduction caused by the non-carbon energy consumption of country i at time t, *Einct and Eit*

denote the non-carbon energy consumption and total energy consumption of country i at time t, respectively. The difference between CI_{icoal} and CI_{it} indicates how much less carbon intensive a country's energy system is compared to a 100% coal-dependent economy. The ratio of this difference and CI_{icoal} – i.e., DCI – reflects how much carbon has been removed from the energy system. The DCI can be further decomposed into sub-indicators representing contributions to decarbonization from oil and gas (DCIOG), as well as contributions from non-carbon energy (DCINC). As such, the DCI fills an information gap left by the traditional indicators, while providing a summary indicator straightforward enough to be the basis of policy-making.

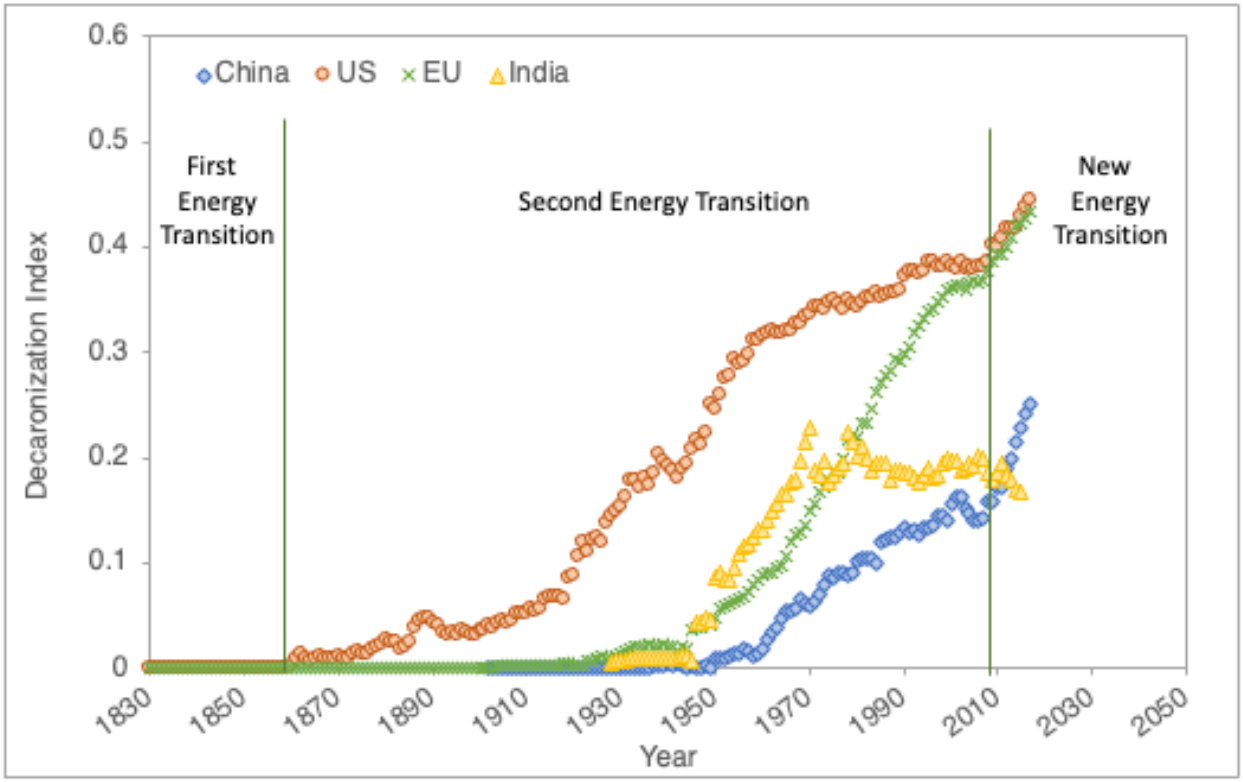
The DCI has four advantages over the conventional indicators and aggregated indexes. First, comparing to non- energy-based indicators, the DCI directly captures the fundamental goal of global energy decarbonization: eliminating carbon content of energy consumption. Secondly, comparing it to emissions intensity (i.e. carbon emissions per unit energy consumption), the DCI is straightforward. Utilizing the carbon intensity of coal, the DCI provides a clear baseline for measuring decarbonization progress. Third, the DCI decomposed to sub-indicators representing decarbonization contribution from different energy sources and technologies. Forth, the DCI can also compensate non-energy-based mitigation approaches (such as negative emissions technologies and carbon sink). As the decarbonization process would become intensively difficult due to technological and political barriers, the DCI could inform policymakers the exact share of carbon they would have to remove from the energy system.

In addition, DCI also helps to review the evolution of the energy transitions, creating a historical context and comparative benchmarks for policymaking. In the following sections, we apply the DCI for analyzing the historical trajectory of energy transitions and the future progress of global decarbonizations. We calculate a country's DCI using emissions and energy consumption data from BP Energy Statistics. The dataset includes data for 73 countries (22 OECD and 51 non-OECD) over the period from 1965 to 2017. Together, they represent about 98% of global energy consumption and global carbon emissions in 2017. To track energy transition through-out history, we also include pre-1965 emissions and emissions factors of different energy carriers from Carbon Dioxide Information Analysis Center (CDIAC) of the U.S. Department of Energy, and pre-1965 energy consumption data from IEA (2022). In the next section, we evaluate the DCI by assessing historical energy transition in major countries.

The history of energy transition: A DCI assessment

The modern economy emerged when the British began to utilize coal on a massive scale. In the late 18th century, coal became the "universal aid" that initiated and energized the first industrial revolution (Wrigley, 1986). Historically, people burned coal for domestic cooking and heating, which is a less efficient way of harvesting the chemical energy in coal. Steam engines fundamentally changed fuel utilization by transforming the chemical power in coal into mechanical power, which enabled mass production. This innovative utilization of fossil fuels provided Great Britain a critical competitive advantage over other nations around the world, and made the country a global superpower.

Figure 1: Historical trajectories of DCI for the EU, the Unites States, India and China.



In the late 1850s, oil was discovered and commercialized in the United States (Yergin, 1990). Systematic utilization of this alternative fossil fuel marks the start of decarbonization in the modern energy system, as oil has lower carbon intensity than coal. As shown in Figure 1 by the red dotted line, the DCI of the U.S. began to rise above zero, meaning its overall energy structure was becoming less carbon intensive, as the scale of fossil fuel use, and thus carbon emissions, grew. In the "Second Industrial Revolution" that began around the 1870s, the

decarbonization process accelerated in tandem with technological innovation and diffusion. Internal combustion engines fueled by oil products promoted productivity and mobility, which ensured a market share for oil. The contributions to decarbonization by oil and gas were enormous. As Yergin (2011) writes: "[Oil] was generous to his loyal subjects. . . [his] reign was a time of confidence, of growth, of expansion of astonishing economic performance." (2011: 523)

This is certainly true of the United States. Since 1900s, its oil and gas consumption has increased dramatically. Up to 1945, the share of oil and gas consumption in the nation's total energy mix reached 0.48, decarbonizing its energy system by nearly 20%. It was also during this time that the US economy surpassed that of the United Kingdom, which still largely depended on coal.

Historically, advanced economies have experienced gradual transitions in the energy mix from coal to oil and gas, and most recently to clean energy sources (e.g., solar and wind power) (Qi et al., 2016). The DCI also helps to review the evolution of the modern energy system, creating a historical context and comparative benchmarks for policymaking. Figure 1 shows the energy transition of the Europe, the United States, India and China over time in terms of DCI. As indicated in Figure 1, the decarbonization of the US and Europe, had been dominated by oil and gas and occurred over a long-time frame. China has followed this pattern, but its rapid transition has been defined primarily by clean energy. The contribution from clean energy to its decarbonization will soon overtake oil and gas, greatly shortening China's hydrocarbon-dependent phase of development. Europe has also been actively ending its oil and gas phase by encouraging renewable energy.

Riding the tide of economic development after World War II, the United Kingdom diversified its energy system and decarbonized at an incredible speed. The share of coal in UK's energy mix decreased from near 99% in 1945 to 16% in 2000. Oil and gas were the main alternatives, their share increasing from less than 1% to 74% during this period. By the end of last century, the United Kingdom had removed 36% of the carbon from its energy system; about the same progress took the United States near one-and-one-half centuries. The United Kingdom received significant economic and environmental benefits from the decarbonization, perhaps most conspicuously in the disappearance of the persistent industrial smog that blanketed London from the late 19th to mid 20th Centuries (Argyriou and Barry, 2021; Boon, 2019).

During the same period, China started industrialization while slowly diversifying its energy consumption. By 2000, China removed 16% of the carbon from its energy mix, driven mainly by oil and hydroelectricity. Yet in the first several years of the 21th century, its DCI fell, mainly due to rapid economic expansion and increasing dependence on coal (Qi et al. 2013). This downward trend was reversed again around 2010. From 2010 to 2016, China's energy decarbonization accelerated, with a rapid increase of 39%, more than half of which came from non-carbon sources (see Figure 2). Such growth in non-carbon energy helped China peak in coal consumption in 2013-2014 (Qi, 2017; Qi et al., 2020), occurring much earlier than most analyses had projected.

The re-engagement with decarbonization was not unique to China. It is rather a global phenomenon. Both the United States and the United Kingdom, as well as the EU, experienced dramatic increases in their DCI around 2010. As shown in Figure 2, from 2010 to 2016, the DCI of the United Kingdom increased by 27% to 0.45, with non-carbon energy contributing to nearly 90% of the total decarbonization progress. Similarly, the EU has been reinvigorating its decarbonization process with renewable energy, although its recent recession in DCINC might signify the difficulty for high renewable energy penetration. While the contribution from non-carbon energy almost doubled in the UK, three quarters of the US' decarbonization progress was due to oil and gas, which explains its much slower rate of improvement (only 10% in six years). If these countries manage to continue decarbonizing at the same respective speeds, the United Kingdom will reach zero carbon emissions in 2056, China in the 2080s, the EU in around 2100, and the United States will need another century. In other words, unless more aggressive decarbonization plans are taken, none of them can fulfill their climate pledges.

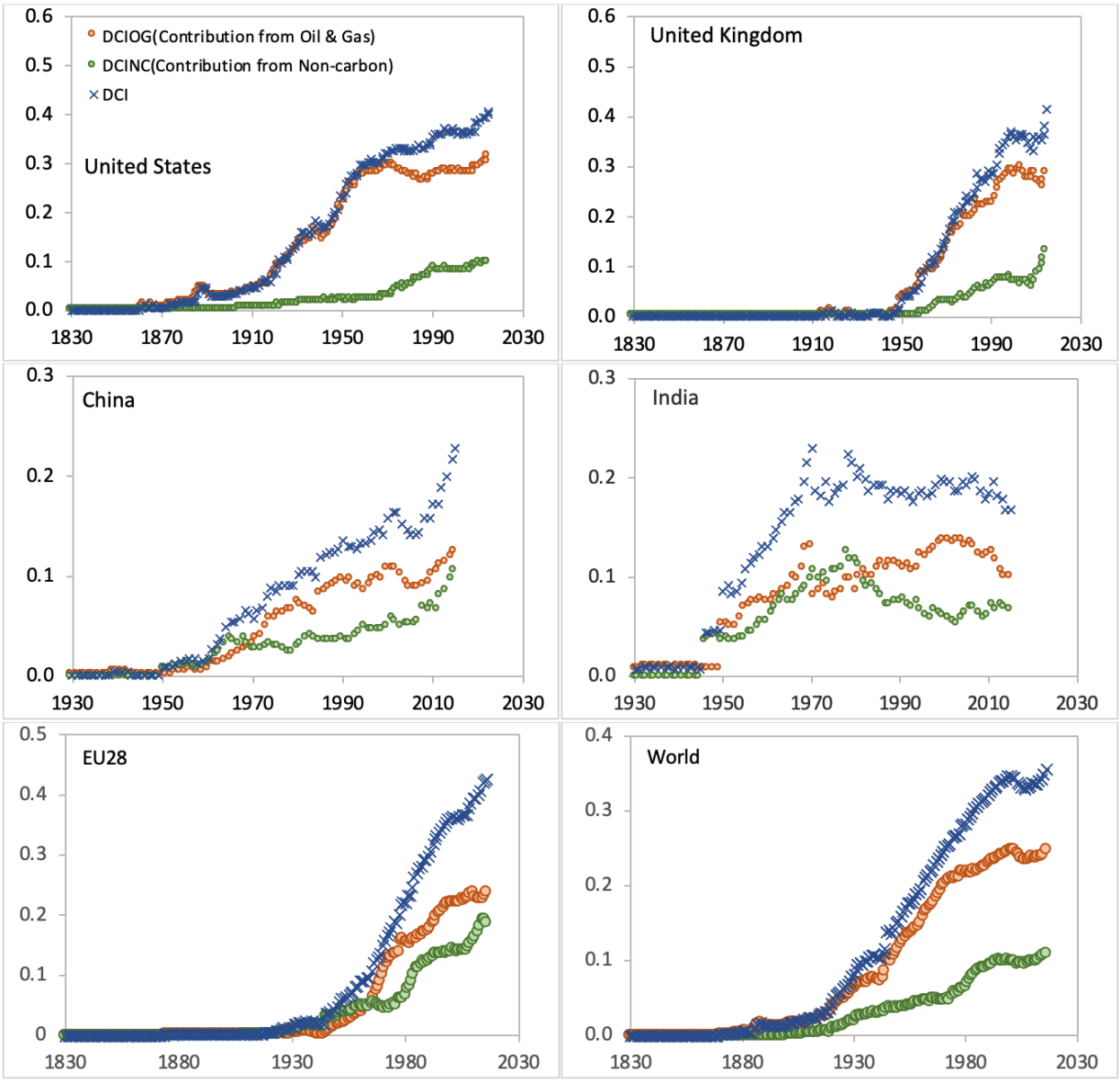


Figure 2: Historical trajectory of DCI and contributions from different energy sources.

In sharp contrast to the other major emitters, India has experienced a 10% regress in energy decarbonization since 2010. Taking into account the size of the Indian population and economy, this has enormous implications for global climate change. Additional effective climate-friendly energy policies and regulation must be implemented to reverse this trend and avoid daunting climate consequences, particularly for India itself, which is projected to be hard hit by impacts and is not adequately prepared for successful adaptation (Rej et al., 2022; Song et al. 2022).

The worldwide concurrence of accelerating decarbonization is hardly a coincidence; rather it is a signal of some larger and deeper social-economic changes. Countries' DCI trajectories

show us that substantial progress in decarbonization often happens at the break of a new industrial revolution: following an industrial revolution and its associated innovation waves, DCI experiences rapid growth, but then slows down until the next massive wave of changes activates a new round of decarbonization. Despite debates over the term (the third according to Jeremy Riffkin, and the fourth according to Klaus Schwab), there is an emerging global consensus that a new industrial revolution is underway. Yet unlike the previous ones, the new industrial revolution has multiple origins (Rifkin, 2011; Schwab, 2017). The transition away from carbon is occurring in both affluent industrial economies and some large developing ones. More importantly, unlike the previous energy transitions that were driven mostly by industrial policies, the new energy transition is driven primarily by climate policies that would not only mitigate climate change but also foster technological innovations (Hansen et al., 2019; Noussan et al., 2020). Table 3 summarizes main categories in terms of energy, technology, origin, and policy tools that facilitate energy transitions.

Table 2. Dominant energy carrier and utilization technology in different Energy Transitions.

Energy transition	**First**	**Second**	**New**
Source of energy	Carbon	Hydrocarbon	Nuclear and Sun
Dominant energy carrier	Coal	Oil and gas	Non-carbon
Dominant technology	Steam engine	Internal combustion engine and electricity	Electricity
Origin	United Kingdom	United States, Western Europe	Multiple origins
Main policy driver	Industrial policies	Industrial and environmental policies	Climate policies

Nevertheless, countries that pioneered the previous energy transition tend to be bridled by its development path, and been reluctant to embrace new energy sources and technologies. As the progenitor of industrialization, it took the UK another half century to diversify its energy mix with oil and gas, which by then had become the mainstay of the energy economy of North America. Like the UK, which was stalled by coal, the US has also been captured by fuels from previous energy transition (Chapman and Itaoka, 2018; Elshurafa et al. 2019; Johnstone and McLeish., 2020). Although the US has cultivated remarkable decarbonization progress by replacing coal with shale-based natural gas over the past decade, from a supply-side perspective, fracking additional natural gas is no more than to double-down on the fossil fuel-fired development path. Even if the US manages to power its entire economy by natural gas, as a hydrocarbon energy, natural gas can only provide up-to approximately 42% of potential

decarbonization. Although frequently touted as a bridge fuel, what has seldom been asked about natural gas in the US is, when should we start to phase it out and to what extent will natural gas forestall the expansion of non-fossil fuel energy? The recent stimulus to renewable-led decarbonization by large-scale Chinese and European investments indicates that additional supply-side climate policy and regulations are necessary for the US to break this path-dependence.

Moreover, the decarbonization process is not always linear, especially for countries that are engaged in catch-up modernization. From 1980 to 2010, India's decarbonization process stagnated, its DCI fluctuating around 0.18 to0.20. In particular, the contribution from non-carbon energy declined. Considering India's recent economic development, it achieved a high growth rate at a similarly high cost of carbonizing its energy system. Economic development driven by a "renaissance" of coal use has also been witnessed for many other developing countries (Markard, 2018; Steckel et al. 2018). The failure to advance decarbonization with large-scale use of renewable energy will greatly impede global efforts at climate change mitigation (Rockström et al. 2017).

Carbon Neutrality as the End for Energy Transitions

As shown in the previous section, the DCI can provide an appropriate assessment of energy technology development and progress of energy transition. In this section, we apply the DCI in the context of the future of global carbon neutrality. As of April 2021, there are more than 40 countries that formally proposed their carbon neutrality target. Considering the impact on the process of carbon neutrality in the world. In this chapter, we analyze 15 countries, which include, China, U.S., EU, Japan, Germany, South Korea, Canada, South Africa, Brazil, U.K., France, Spain, Netherland, Ukraine, and Argentina. Each country emits more than 0.5% of the world's total carbon emissions in 2020, according to BP (2020) and IEA (2021). Twelve out of the 15 major countries/regions in our study have set their carbon/climate neutrality targets by 2050, and three countries, China, Brazil, and Ukraine, have set their carbon/climate neutrality targets by 2060, therefore, we divide the current target constraints into two phases:

First, we compare the existing NDC targets under the Paris Agreement. All the 15 countries/regions have put forward their own NDC carbon neutrality plans and related energy consumption outlooks. Table S1 in SI summarize the NDC targets of 14 countries and the EU. We reviewed the two rounds of NDC documents submitted by the 15 countries to the UN and

searched those domestic and international studies from authoritative international organizations like IEA (2021) and BP (2020), Therefore, based on the emissions data and their energy outlooks, we calculate and demonstrate the projected DCI of these countries.

Second, we compare NDC target to carbon neutrality target stage. To achieve the carbon neutrality target, net carbon emissions or net greenhouse gas emissions will be no more than 0. In this study, we consider the long-term trend by focusing on the variables that directly affect the sources and sinks of carbon emissions, leaving out the indirect, albeit significant factors of technology, economy and society. Based on existing studies, this analysis assumes two types of carbon sinks, i.e. carbon fixation by terrestrial ecosystems and carbon capture and sequestration (CCS), and two terms of carbon sources: emissions from energy combustion and industrial processes. To achieve the carbon neutral target, net carbon emissions or net greenhouse gas emissions will be no more than 0. If we assume the industrial carbon emissions, carbon sink through CCS and forest carbon sinks of carbon-neutral countries based on existing studies, countries' resource endowments, medium- and long-term energy and CCS development plans, and the ratio of energy-related carbon emissions to energy-related greenhouse gas emissions, then we can get the maximum energy-related carbon dioxide emissions in a carbon-neutrality year.

For the countries where targets are carbon neutrality, the goal of carbon neutrality is:

$$NCE_{it} = C_{it}(E) + C_{it}(Ind) - C_{it}(CCS) - C_{it}(Forest) \quad (4)$$

where Cit(E) and Cit (Ind) are carbon emissions from the energy sector and the industrial sector, Cit (CCS) and Cit (Forest) are carbon sink by ecosystems and CCS equipment. And at the target year T,

$$NCE_{iT} = C_{iT}(E) + C_{iT}(Ind) - C_{iT}(CCS) - C_{iT}(Forest) \leq 0 \quad (5)$$

$$C_{iT}(E) \leq C_{iT}(Ind) - C_{iT}(CCS) - C_{iT}(Forest) \quad (6)$$

For the countries where targets are climate neutrality or net zero emissions, the goal of climate neutrality is

$$NCE_{it} = C_{Git}(E) + C_{Git}(Ind) - C_{it}(CCS) - C_{it}(Forest) \quad (7)$$

$$C_{Git}(E) = C_{iT}(E) + C_{OiT}(E) \quad (8)$$

where $C_{Git}(E)$ and $C_{Git}(Ind)$ are total greenhouse gas emissions from the energy and industrial sector, $C_{it}(CCS)$ and $C_{it}(Forest)$ are carbon sinks in ecosystems and CCS

equipment, $C_{iT}(E)\ and\ C_{OiT}(E)$ are carbon emissions from the energy sector and other greenhouse gas emissions from the energy sector. And at the target year T,

$$NCE_{iT} = C_{GiT}(E) + C_{GiT}(Ind) - C_{iT}(CCS) - C_{iT}(Forest) \leq 0 \quad (9)$$

$$C_{GiT}(E) \leq C_{GiT}(Ind) - C_{iT}(CCS) - C_{iT}(Forest) \quad (10)$$

$$C_{iT}(E) = C_{GiT}(E) - C_{OiT}(E) \quad (11)$$

Thus, the DCI scores of the NDC target year and carbon-neutrality target year are shown in Table 3. We find that 14 of the 15 countries or regions have designated 2030 as their NDC target year, whereas the United States' NDC target is to reduce carbon emissions by 26 percent to 28 percent in 2025 compared to 2005 levels. China has pledged to peak its emissions before 2030, but has not set any particular objectives for lowering carbon emissions by 2030.

In addition, 12 of the 15 countries have designated 2050 as their carbon neutrality target year, with China, Ukraine, and Brazil projecting 2060 as their carbon neutrality year. The difference between current and predicted DCI ratings varies substantially amongst countries, ranging from 0.7 to 0.2, demonstrating that each country's energy transition pressure is unique.

Using 2019 as the base year, these 15 nations and regions' total carbon emissions totalled 22104 MT, accounting for 43.20 percent of global carbon emissions. Canada, France, and Brazil are among the nations with a DCI of above 0.6, with France having the highest DCI of the 15 countries or regions analyzed in this study due to nuclear power's approximately 40% share of total energy consumption. Other nations' DCI ratings range from 0.4 to 0.6, with the exception of China and South Africa. China has a DCI of 0.271, whereas South Africa has a DCI of 0.134, the lowest among these 15 nations or regions.

From 2019 until the year when the NDC targets are met, these 15 nations' total carbon emissions will decrease by 12.03 percent to 19,444 Mt. Some nations, such as France, Canada, and Brazil, will score more than 0.7 on the DCI index. Most developed countries' DCI scores will increase from 0.4 to0.6 to above 0.6. China and South Africa are two of the few nations that rely on coal as their primary source of energy, and their DCI ratings in the first stage are low, indicating delayed growth.

Table **Error! No text of specified style in document.**. Short-term and long-term DCI score

Country/Region	Carbon Emissions in 2019 (m tons)	DCI_{now}	NDCs Year	Estimated emissions (m tons CO_2)	DCI_{ndc}	Year of carbon/climate neutrality	Estimated emissions (m tons CO_2)	DCI_{neu}	DCI gaps
South Africa	479	0.134	2030	377	0.258	2050	68.4	0.839	0.705
China	9825	0.271	2030	10251	0.34	2060	1850	0.867	0.596
Japan	1123	0.420	2030	975	0.484	2050	158	0.914	0.494
German	684	0.492	2030	453	0.659	2050	52.3	0.953	0.461
Netherland	192	0.466	2030	132	0.608	2050	23	0.923	0.457
Ukraine	185	0.468	2030	142	0.584	2060	24.4	0.925	0.457
South Korea	639	0.496	2030	488	0.608	2050	80	0.934	0.438
U.S.	4964	0.488	**2025**	4289	0.637	2050	887	0.914	0.426
EU	3330	0.527	2030	1955	0.708	2050	403	0.934	0.407
U.K.	387	0.518	2030	259	0.65	2050	52.1	0.924	0.406
Spain	279	0.525	2030	192	0.644	2050	36.3	0.921	0.396
Canada	556	0.618	2030	363	0.74	2050	38	0.97	0.352
Brazil	441	0.652	2030	339	0.738	2060	60.4	0.956	0.304
Argentina	175	0.507	2030	133	0.598	2050	63	0.801	0.294
France	299	0.698	2030	221	0.766	2050	58.8	0.909	0.211

The second phase runs from the year in which the NDC targets are met to the year in which carbon neutrality is achieved. These 15 countries/regions will then to cut carbon emissions by 83.5 percent to 3,655 MT during the next 30 or 40 years, compared to the current level. Over the next 40 years, China, for example, will cut its carbon emissions by around 7,975 Mt. In these countries/regions, the DCI index must likewise be around 0.9.

As illustrated in Figure 3, we also compare the existing DCI, goal DCI, and yearly growth rate of DCI. We find that the greatest DCI annual growth rates are required to attain carbon neutrality in South Africa, Japan, and Germany; China's DCI annual growth rate can be slightly lower than these nations' since it has committed to carbon neutrality in 2060, ten years later than other countries. France and Brazil are most likely to reach carbon neutrality on time, given nuclear power and hydropower have already make for a major share of their energy mix.

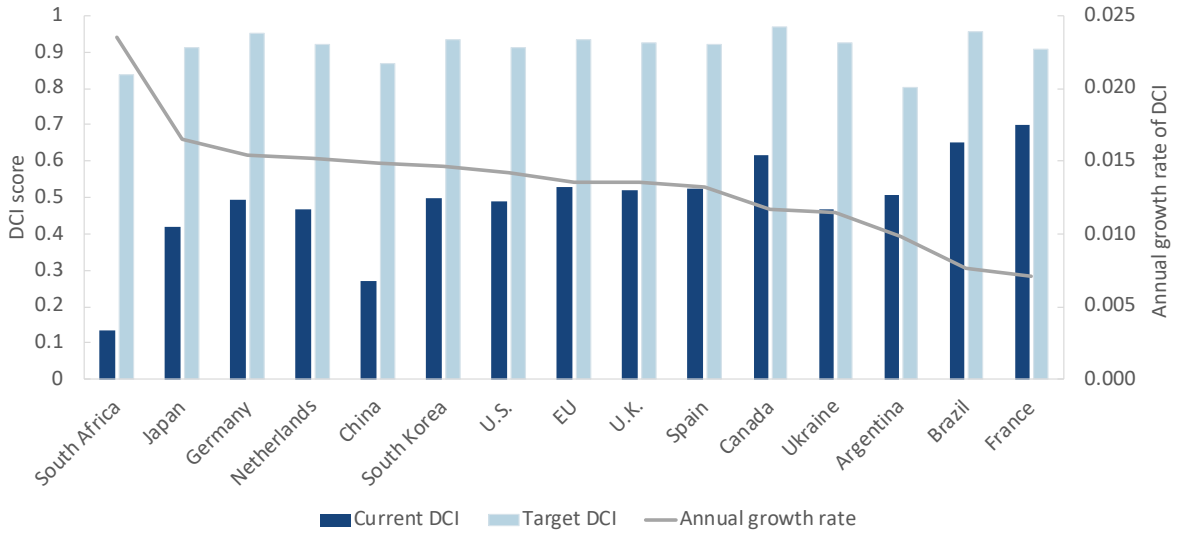


Figure **Error! No text of specified style in document.**. The DCI score and annual growth rate of 15 countries

Based on the DCI scores of the historical and target years, we assume that the DCI of the intermediate years is a weighted superposition of the linear and exponential changes:

$$DCI(t) = \lambda DCI_{exp}(t) + (1-\lambda)DCI_{lin}(t) \tag{12}$$

$$DCI_{lin}(t) = DCI_{lin}(t_0) + [DCI_{lin}(t_1) - DCI_{lin}(t_0)] * (\frac{t-t_0}{t_1-t_0}) \tag{13}$$

$$DCI_{exp}(t) = DCI_{lin}(t_0) * [\frac{DCI_{lin}(t_1)}{DCI_{lin}(t_0)}]^{(\frac{t-t_0}{t_1-t_0})} \tag{14}$$

where $DCI(t)$ is the DCI index of year t ; $DCI_{exp}(t)$ and $DCI_{lin}(t)$ are the DCI indices that change linearly and exponentially with time, respectively. λ is a weight factor between 0 and 1, which can be treated as a random variable according to different scenarios. Here, we assume that DCI mainly experience linear changes, so λ=0.2. $t_0$and t_1 represent the historical base year and target year respectively. For example, for the EU, $t_0 = 2019, t_1 = 2030$ in the first stage and $t_0 = 2030, t_1 = 2050$ in the second stage.

Figure 4. DCI development paths to achieve carbon neutrality of 15 countries/regions

Figure 4 depicts the required DCI development paths for China, the United States, and the EU in line with their NDC and carbon neutrality targets. The gray line indicates the changes in both historical and projected DCI scores, while the green and blue lines represent the shifts in DCIOG and DCINC scores, respectively. The dark blue line represents the BAU (business as usual) scenario, reflecting the prevailing trend from 2015 to 2019. DCI development paths for the remaining 12 countries and regions can be found in Appendix 2.

(1) Evaluating the shifts in DCI-fossil and DCI-non-fossil reveals that, currently, oil and gas as well as green energies have largely supplanted coal in many countries. Both DCI-fossil

and DCI-non-fossil contribute almost equally to the overall DCI. Moving forward, the share of DCI-fossil is anticipated to decline, making DCI-non-fossil the dominant contributor to DCI. The primary strategy to achieve carbon neutrality will hinge on replacing fossil fuels with renewable and nuclear energies. While oil and natural gas might persist in certain sectors, non-carbon are expected to dominate the energy consumption in these nations over the next three to four decades.

(2) For both the United Kingdom and Brazil, the DCI trend line surpasses the projected DCI line, suggesting that their decarbonization index's growth over the past five years has outstripped the demands for carbon neutrality. By sustaining their current DCI growth rate, these nations stand a good chance of achieving their carbon neutrality goals on time.

(3) In the cases of China and Japan, the DCI trend line intersects with the projected DCI line. This indicates that these two nations have initiated their energy system's decarbonization process. While their present DCI growth rate aligns with their NDC objectives, an accelerated pace is necessary to meet their carbon neutrality ambitions. Specifically for China, its DCI-fossil remains consistently below 0.1 for the upcoming 40 years. Having not ventured extensively into oil and gas, China is poised to transition directly from coal to renewable energy sources.

(4) For Ukraine, Argentina, and the majority of EU nations, the DCI trend line displays a modest upward trajectory. However, it remains beneath the projected DCI line, suggesting that their current energy system transition pace is inadequate to reach both NDC and carbon neutrality milestones. Notably, Canada, South Korea, and Spain have exhibited either stable or fluctuating DCI scores in recent years, with no discernible upward trajectory, indicating a plateau in these nations' energy system's low-carbon transition. To invigorate the transition in these nations, a blend of robust policy and financial measures is imperative.

(5) South Africa faces the most formidable challenges in transitioning its energy system towards low carbon. The nation's current DCI does not display a marked increase and even lags behind its score from 2000. With its DCI-non-fossil standing below 0.1 and a sluggish progression in renewable energy, South Africa's road to carbon neutrality requires its DCI to leap by almost 0.6 in three decades and its DCI-non-fossil to climb by 0.7. This necessitates an annual growth of over 2% in the renewable energy share of its total energy consumption. Such a monumental transition demands innovative technologies, along with supportive policies and regulations.

In sum, to attain carbon neutrality, the mean DCI for the 15 countries should approximate 0.9, with DCI-non-fossil contributing up to 0.85. Developed regions, exemplified by the European Union, will experience a phased transition where oil and gas initially supplant coal. Subsequently, DCI-fossil will taper off, culminating in renewable energy sources overtaking oil and gas. Contrastingly, in developing nations, epitomized by China, oil and gas play a minimal role in the decarbonization trajectory. This is largely because renewables are set to directly supplant coal, leading to a swift ascent in their DCI-non-fossil.

Strategies for energy transitions

The current emission reduction technologies mainly consist of energy efficiency improvement and non-fossil energy technologies, through which it is expected that carbon emissions can be significantly reduced. However, as shown in the analysis above, the timing of decarbonization is subject to the influence of key socio-technological factors, such as the breakthroughs of key technologies and the scale of their applications (Kern and Rogge, 2016; Kern and Rogge, 2018; Sovacool, 2016; Sovacool and Geels, 2016; Sovacool, 2011). Government actions and policy support is critical for accelerating the energy transitions by facilitating energy technology innovation and deployment. Under the framework of the Paris Agreement, governments are obligated to submit decarbonization plan and periodically update their climate actions. Here, we use NVIVO11 to carry out a content analysis on the NDC documents and long-term emission reduction plans announced by national governments, and categorize the carbon neutrality related policies by various countries, which is collected from official website and government documents.

To conduct the content analysis on the energy transition policies instruments, we firstly identify the relevant policy instruments. Using the framework summarized by Qi et al. (2023) and Liu et al. (2020), we have identified 16 policy instruments from four areas (comprehensive transition policy, fossil energy efficiency improvement, non-carbon energy development and reform of the energy utilization system) and three aspects (planning/standards, market mechanism and information instruments). These could include measures such as renewable energy targets, carbon tax, subsidies for non-carbon energy development, industrial energy saving standards, and other policies aimed at reducing greenhouse gas emissions and transitioning towards a low-carbon economy. Table 4 illustrates the categories of existing transitions policies.

Secondly, we collected the national energy transition policies from the official websites of these 15 countries. These websites could include the official government website of each country (for example, www.gov.cn), and also include the website of relevant government departments, such as Ministry of Energy, Ministry of Environment, or some other department or agency (for example, www.mee.gov.cn). Meanwhile, the NDC documents could also help us conduct the context analysis since they are at the heart of the Paris Agreement and the achievement of its long-term goals, and embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. Subsequently, this study will use the data collection method of bibliometric and machine learning technology to collect and screen relevant policy documents on energy transition policy instruments, and finally identified 120 sample policy documents, which has been published before December 31th, 2021.

Thirdly, the policy documents included in the content analysis have been coded by NVIVO 11, including the description of content characteristics and the collection of corresponding statistics of policy instruments. The main variables that need to be coded in this study include the use of specific energy transition policy instruments mentioned in national policy documents, including those already used and those to be used. At the same time, in order to ensure the mutual independence of research samples in policy documents, if there are differences in the mention or expression of the same policy instrument in two policy documents, this study will adopt the latest policy document for encoding (for example, the 2020 policy document mentions that the policy instrument would be implemented, and the 2021 policy document mentions that the policy instrument has been implemented, then this study coded it as already implemented). To ensure the accuracy of coding. The coding work of this paper will be independently carried out by three researchers. After the coding is completed, the effective eigenvalues will be extracted from the samples composed of 120 policy documents. Table 4 illustrates the categories of existing transitions policies, and the result of different countries is shown in Table 5 and Table 6.

Table 4. Categories of energy transition policies

Policy instruments	Comprehensive transition policy	Fossil energy efficiency improvement	Non-carbon energy development	Reform of the energy utilization system
Planning/Standards	Medium– and long-term energy transition target and plan	Green building standard Green transportation standard Industrial energy saving standard	Renewable energy legislation Hydrogen energy planning or roadmap	Smart grid construction standard and Electrification goals
Market mechanism	Carbon Tax Carbon Market	Energy efficiency subsidies	Subsidies for non-carbon energy development	Flexible pricing mechanism of electricity
Information instruments	Public awareness improvement	Energy efficiency labeling	MRV system of carbon emissions	Electricity Demand Side Management (DSM)

As demonstrated in Table 5 and Table 6, among the developed countries, EU countries have established a comprehensive carbon neutrality policy system, and all the 16 indicators except the carbon tax are included in their official planning or legal documents. In March 2021, the European Parliament also voted to establish the Carbon Border Adjustment Mechanism (CPAM). It decided that from 2023, exports from countries that trade with the EU that do not comply with rules on carbon emissions would face carbon border tax. Therefore, the EU provides the most comprehensive policy support for carbon neutrality. Among the EU countries, except Germany, which does not implement carbon tax, France, Spain, the Netherlands and the UK which just left the EU also have a complete carbon neutrality policy system, while Japan, South Korea and South Africa also have a comprehensive policy system for carbon neutrality.

For developing countries, such as China, Brazil and Argentina, the current carbon-neutrality policy framework is still requires further specification. For example, China and Brazil lack development plans for hydrogen energy and long-term energy transition plan, while Argentina lacks domestic development plans for electrification.

Combining with the above analysis of the DCI index, we find that due to the demand of economic development and the pressure of energy consumption growth, although developing countries have committed to carbon neutrality relatively later compared with the developed countries, it is more difficult for them to achieve carbon neutrality than developed countries, as shown in Figure 5. For example, South Africa is facing the greatest pressure of energy transition, and it still lack a comprehensive policy framework to deliver its carbon neutrality target in time. Therefore, South Africa must soon to adopt a major push for more effective policies.

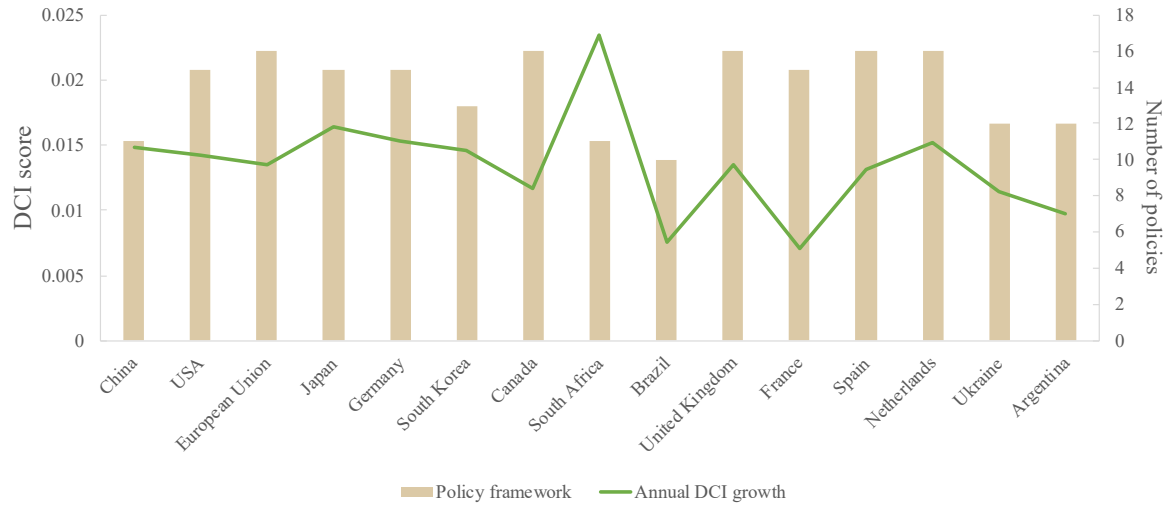


Figure 5. Comparison with the policy framework and annual DCI growth in each country.

Table 5. The current system of policies that countries have implemented (summarized by author)

	Comprehensive transition policy		Fossil energy efficiency improvement							Non-carbon energy development				Reform of the energy utilization system		
Country/Region	Energy transition plan	Carbon Tax	Carbon Market	Energy impact assessment	Green building standard	Green transportation standard	Industrial energy saving standard	Energy efficiency subsidies	Energy efficiency labelling	Renewable energy legislation	Hydrogen energy planning or roadmap	Subsidies for non-carbon energy	MRV	Electrification goals	Flexible pricing mechanism	DSM
China	N	N	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N
USA	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
European Union	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Japan	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Germany	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
South Korea	N	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Canada	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
South Africa	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	N	N
Brazil	N	N	N	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	N
United Kingdom	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
France	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Spain	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Netherlands	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ukraine	Y	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Argentina	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	N

Table 6. The current system of policies that countries have announced to be implemented (summarized by author)

	Comprehensive transition policy		Fossil energy efficiency improvement							Non-carbon energy development				Reform of the energy utilization system		
Country/Region	Energy transition plan	Carbon Tax	Carbon Market	Energy impact assessment	Green building standard	Green transportation standard	Industrial energy saving standard	Energy efficiency subsidies	Energy efficiency labelling	Renewable energy legislation	Hydrogen energy planning or roadmap	Subsidies for non-carbon energy	MRV	Electrification goals	Flexible pricing mechanism	DSM
China	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y
USA	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
European Union	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Japan	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Germany	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
South Korea	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Canada	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
South Africa	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
Brazil	N	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	N
United Kingdom	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
France	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Spain	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Netherlands	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ukraine	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Argentina	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N

Conclusion and Discussion

In this chapter, we review the global energy transitions and the potential trajectories for energy transition to achieve carbon neutrality. We first review existing indicators for analyzing decarbonization, and then introduce a new indicator, DCI, to assess the progress of energy transition, which could help us understand the logic of energy transition and illustrate the connection between the energy transition and industrial revolution quantitively. We apply the DCI for assessing historical energy transitions in the United Kingdom, the United States, China, and India. Then, the scores, paths, and difficulties of carbon neutrality for 15 countries and regions, whose total carbon emissions exceed 0.5% of the world's total, are evaluated using the DCI index. It was discovered that South Africa, Japan, and Germany require the highest annual growth rates in DCI to achieve carbon neutrality. Meanwhile, France and Brazil are countries most likely to achieve carbon neutrality within the given timeframe, thanks to significant contributions from non-carbon energy sources like hydropower and nuclear power, which already constitute a substantial portion of their energy systems. However, we also find that the BAU scenarios of most countries cannot support the goal of achieving carbon neutrality. Therefore, policymakers must develop proper tools and take firm actions to accelerate the energy transitions in order to fulfill their climate pledges. Finally, by comparing the NDC documents and governments' long-term emission reduction plans, we find that developing countries are facing more serious challenges for delivering their commitment.

Since the Pandemic and the Russia Invasion, the global energy supply chain has experienced serious disruption. The geo-politics of energy has once again been amplified by Russian invasion of Ukraine, taking a heavy toll on the global energy transitions. Although we include only the level of decarbonization in the computation of the energy transition gap, energy security is still an external driving factor that cannot be disregarded in the process of energy transition. Since 2021, global energy commodity prices have continued to grow and inflated by the Russian invasion, greatly exceed pre-COVID-19 levels. IPE's UK Gas index surged 264 percent from 2021 to the end of October, while stocks in Europe and the US dropped. Since Europe, especially Germany, has been relying primarily on Russian-based natural gas, the price of electricity has soared as a result of the war and Western sanctions. In particular, Germany has announced that it will delay the phase out of coal given the current

such as China, reassurance efforts within the existing international order can be an effective way to ease the tensions with the hegemon. Cooperation with the United States on issues of high-importance manages the risk of confrontation in both near- and long-term (Lieberthal and Sandalow 2009).

Under the current political climate, it is hard to foresee the prospect of US-China climate cooperation in the future. Even after the United States comes back to the climate table under the Biden Administration, the United States and China still must navigate troubling water of worsening mutual distrust and antagonism that rooted much deeper than just four years ago. Once again, both U.S.-China relations and the fate of global climate governance are at a crossroads: if the bi-literal relations remain locked in a toxic zero-sum confrontation, it is possible that their actions will eventually lead to a global climate catastrophe, if not an armed collision between two nuclear great powers.

Chapter 3

Cultivating Climate: U.S.-China Relations and the Making of the Paris Agreement

Introduction

In the 2015 Paris Climate Agreement, nearly 200 countries committed to limiting global temperature increase to less than two degrees Celsius (UNFCCC 2015). To achieve this goal, today's fossil-fuel-reliant global energy regime would have to almost eliminate the use of fossil fuel by mid-century (Rogelj et al. 2018). Although the effect and future fate of the Paris Climate Agreement is still open to debate, the treaty has arguably started a new era of global climate governance. The Paris Agreement is unique in many ways, but one of its most important advancements is that for the first time since its establishment, China committed to an absolute amount of emission control in an international treaty. Just six years ago, at the COP15 in Copenhagen, the world's largest emitter refused to make any binding commitment to combatting climate change, claiming that developed countries, instead of developing countries, are the ones responsible for current climate problems. Western climate negotiators called the Chinese negotiators "Mr. No" for their firm rejections of Western proposals.

Yet, this firm position took a sudden turn in late 2014 when China and the United States surprised the world by signing the *Joint Announcement on Climate Change and Clean Energy* during President Obama's visit to Beijing for the APEC Summit. In the announcement, China committed to peak its carbon emissions around 2030 and increase its share of non-fossil fuels use to 20 percent of the total primary energy consumption by 2030. One major reason for its importance is that China, for the first time, committed to a target of absolute emissions control,

something that developed countries have pushed for years. In the year leading up to the Paris Conference, China signed bi-lateral and multilateral announcements on climate change and clean energy with major countries around the world, including Brazil, France, Germany, Russia, India, and the United Kingdom. Eventually, these announcements were institutionalized in the Paris Agreement as a politically binding international treaty. Many see China's efforts and leadership as the main driver of the success of the Paris Agreement (Christoff 2016; Eckersley 2020). One might find it hard to imagine that are recent as 2013, China's non-cooperation was a major reason for the failure of yet another round of international negotiation on climate issues. What explains China's sudden change of attitude toward the global governance of climate change?

International relations and public policy literatures on China's climate governance and global public good provision focus primarily on domestic factors (Cho 2021; Duggan 2020; Lai and Kang 2014; Wong 2018; Ye 2019). Existing works on China's proactive participation in the Paris Climate Agreement mostly attribute its enthusiasm for the climate agreement to domestic factors, such as China's changing economic structure (Green and Stern 2017), industrial policy (Chen and Lees 2016), environmental problems and climate vulnerability (Bernauer et al. 2016; Brødsgaard 2016; Yang and Teng 2018). While these domestic factors could be necessary conditions for China to initiate cost-effective climate actions, they are insufficient in explaining the patterns and timing of the sudden change of attitude toward a binding climate agreement with binding elements, because China's domestic policy orientation were inconsistent with its international climate strategy.

In addition to liberal arguments, realist theory has also been used to explain China's international strategies, and sees China as a revisionist of international order. On climate issues, realism can explain China's inaction in global climate governance. Scholars pointed out that China resisted binding international climate agreement because it deemed climate change an excuse for restraining China's economic development and the path to "the great revival of the Chinese nation" (Brenton 2013; Hallding et al. 2013; Terhalle and Depledge 2013). In this chapter, I assess existing explanations, demonstrating that those interpretations are insufficient to explain China's climate activism. Using process tracing and key-player interviews, I conclude that China's decision to play the leadership role on climate change in making the Paris Agreement has a palpable and specific realist incentive: as a rising power, China is actively trying to deescalate the tension between itself and the hegemon – the United States –

by engaging in diplomatic dialogue and cooperation that cultivating a friendly climate on the international stage, avoiding further decoupling with the United States and the West.

The rest of this chapter proceeds as follows. First, I review existing literature on the power transition theory and great power relations as they apply to U.S.-China relations. I contend that the rising power has a strong incentive to cooperate with the hegemon given the threat of conflict. Second, I evaluate the existing arguments, which emphasize the long-term trend of China's domestic political-economic factors. I show that China's domestic policy orientation and the timing of reaching a consensus among the leadership are inconsistent with China's international strategy. Third, I then discuss China's role as a rising power on the international stage and its increasing tension with the United States after 2008 under the theory of great power politics. Fourth, by drawing evidence from interviews and conversations with influential decisionmakers and negotiators from both countries, I provide evidence to support the realist explanation for China's decision to actively participate and lead international climate cooperation, highlighting the importance of US-China relations. I also conduct a counterfactual analysis of the challenge of U.S.-China relations under the Trump Administration and early Biden Administration. Finally, I conclude with a brief discussion about the characteristics of reassurance strategies and the implications for the future of U.S.-China relations and global climate change governance.

Power Transition and Great Power Politics

Path to the Thucydides Trap

Pessimistic realist theory contends that China's rise threatens the United States, drawing from the observed historical pattern of the succession of hegemonies (Gilpin 1981), which eventually leads to the tragedy of great power politics (Mearsheimer 2001). The power transition theory assumes that the rising power would become increasingly dissatisfied with the hierarchical status quo set by the hegemon as its power grows (Organski and Kugler 1980). Therefore, the rising power has incentives to engage in assertive activities, which are defined by Alastair Iain Johnston as "a form of assertive diplomacy that explicitly threatens to impose costs on another actor that are clearly higher than before (p.6) (Johnston 2013)." Rising powers are inclined to utilize their growing power and adopt assertive measures to revise international orders in their favor. In response, the hegemon that is in relative decline would intend to initiate

preventive measures, including technology embargo, containment measures, to halt the power shift (Copeland 2001), which ends up increasing the risk of wars.

Under the power transition theory, the commitment problem lies at the center of the power-transition models (Tingley 2017). The existing hegemon would always be insecure about losing the hegemonic status because the rising power cannot make a credible commitment. Therefore, the strategic intentions of great powers are fundamentally inscrutable (Rosato 2015), especially for the rising powers and the hegemon. As the strength of the rising power continues to grow over time, its behavior on the international stage becomes assertive and aggressive, the possibility of conflict and war would escalates after crises and confrontations (Bueno De Mesquita and Lalman 1988; Bueno de Mesquita and Lalman 2017). The risk of war is particularly high when the rising power is an authoritarian regime, which lacks robust domestic institutions for credible commitments (Kydd 2007).

In the context of U.S.-China relations, China is untrustworthy for the United States in the following areas: 1) China's economic behavior, including currency manipulation and intellectual property theft, would impose direct costs on the United States economy; 2) Investment from China, especially in infrastructures and the information industry, poses national and information security threats on the United States; 3) China's growing military capacity and increasingly intrusive measures in the East and the South China Sea threaten the freedom of navigation of the United States and its allies (Indyk, Lieberthal and O'hanlon 2012; Lieberthal and Jisi 2012).

For China, the distrust is mutual (Lieberthal and Jisi 2012). The Chinese leadership is known for their firm belief in the theory of great power politics, especially the part about how the conflict between a rising power and the hegemon is inevitable (Indyk, Lieberthal and O'hanlon 2012; Lieberthal and Jisi 2012). China's distrust of the United States has a deep historical roots. In terms of regime security, the Chinese have long seen America's democracy-promoting agenda as a design to sabotage the Communist Party's leadership. China, therefore, believes that it should actively guard against the American ideology of democracy, human rights, and the rule of law. It also deems the American military presence in East Asia and the South China Sea an active effort to contain China. Another popular belief among top Chinese politicians is that the United States is taking advantage of the dollar being a reserve currency to adopt various protectionist measures in the name of national security to disadvantage China economically.

The distrust between the United States and China has real-world implications, in both the long run and the short run. First, crises provoked by misjudgments and accidents raise tangible and immediate concerns. Goldstein (2013) points out that, considering the poor quality of existing channels of crisis communication between the two countries, the risk of inadvertent escalation over accident is high. Experts close to decisionmakers in both countries confirmed this assessment, and expressed serious concerns over the misjudgment and miscommunication problem[1], especially regarding potential military hotspots such as Taiwan and the East and the South China Sea. In the age of increasing mutual distrust, the risk of short-term crisis instability is exceptionally high.

Second, in addition to the consequence of accidents, the distrust reflects a long-term pattern in great power politics. The rapidly expanding economy and military expenditure provide the necessary capacity for the rising power to expand its definitions of interests. As a result, the rising power is "often drawn to challenge territorial boundaries, international institutional arrangements, and hierarchies of prestige that were put in place when they were relatively weak (p.19)(Friedberg 2005)." The threat of China becomes tangible and imminent. China, like previous rising powers in history – the United Kingdom, Germany, as well as the United States – would inevitably challenge the hegemon-led international order. In response, the current hegemon – the United States – would be inclined to wage preventive measures to destroy or dismantle the rising power before its power overgrows the established one. On top of this general trend, the rise of Communist China is perilous because of its authoritarianism and growing nationalism (Allison 2017).

However, the rising power and the hegemon do not clash into conflict overnight. At the beginning, the power gap is large enough that the rising power does not pose a tangible threat to the hegemon. When the rising power still adheres to the existing international order, the relationship between them is more cooperative. On their path to confrontation, the threat of the rising power would becomes increasingly salient to the hegemon, and thus the space for cooperation will gradually diminish. The relationship shifts from a cooperative mode to zero-sum competition and confrontation. As tensions increase, conventional areas of cooperation diminish. The rising power has a strong incentive to prevent conflict while still benefiting from the existing world order and the pan-hegemonic peace. Also, considering the power gap, however measured, the rising power is strongly incentivized to minimize the risk of

[1] Conversation with Cheng Li, Director of the John Thornton China Center at the Brookings Institution.

confrontation with the hegemon. As the rising power is growing faster than the hegemon, the longer it could delay the conflict, the higher the chance it has of winning. The rising power's incentive for de-escalation would be the strongest when the power gap is large and gradually decreases as it catches up. In other words, the incentive is proportional to the power gap. Depending on the cost, the rising power would be willing to make a concession or explore a new area of cooperation to avoid security or economic clashes with the hegemon. Although the risk management strategy is hardly a credible commitment, it could reduce the risk of immediate conflicts and avoid losses, buying time for the rising power to better prepare for the inevitable conflict in the future.

In this chapter, I define risk management as a hedging mechanism utilized by the rising power to control or deescalate both long and short-term tensions with the hegemon. In the empirical section, I will use process tracing to elucidate the making of the Paris Agreement. I point out that as traditional cooperation areas between China and the United States continued to shrink since 2011-12 (Indyk, Lieberthal and O'hanlon 2012), the tension between China and the United States intensified. When dialogues with the United States on trade, security, and human rights issues stagnated, China was eager to explore a new area for sustainable bilateral cooperation to manage the risk of direct confrontation. I argue that China tried several measures to get the United States sit-down on the table, including redefining the bi-lateral relations as "New Model of Great Power Relations" with an emphasis on the peaceful transition of power, establishing the Asia Infrastructure Investment Bank (AIIB) using Western (mostly American) standards, and expressing the willingness for cooperation on climate governance. As the other measures failed to deliver, climate change rose quickly to the top of China's international agenda. Striking a climate deal became the new point of cooperation to avid dangerous decoupling and escalation with the United States.

Even though scholars are still debating China's role in the future international order, the politicians in Washington predominantly see China as a major threat to the US-led liberal international order (Doshi 2021). For the United States, China is untrustworthy in the following areas: 1) China's economic behavior, including currency manipulation and intellectual property theft, would impose direct costs on the U.S. economy; 2) Investment from China, especially in infrastructures and the information industry, poses a national and information security threat to the United States; 3) China's growing military capacity and increasingly intrusive measures in the East and South China Sea threaten the freedom of

navigation of the United States and its allies (Indyk, Lieberthal and O'hanlon 2012; Lieberthal and Jisi 2012).

The Thucydides trap emphasizes war as the end of the great power relations. However, in reality, great powers have strong incentives to avoid war, especially when the other side has a functional nuclear arsenal. Both sides thus have strong incentive to de-escalate tensions by reassuring each other that it is willing to play under the existing order.

In the following sections, I build on the power transition theory and argue that China has a strong incentive to cooperate in the assurance game to control or deescalate tensions with the U.S. In the empirical section, I use process tracing to elucidate U.S.-China cooperation on climate change. I point out that as traditional cooperation areas between China and the United States continued to shrink since 2011 (Indyk, Lieberthal and O'hanlon 2012), the tension between China and the United States increased. When dialogues with the United States on trade, security, and human rights issues stagnated, China was eager to explore a new area for sustainable bilateral cooperation to manage the risk of direct confrontation. I argue that China tried several measures to get the United States to sit down at the table, including redefining the bi-lateral relations as "New Model of Great Power Relations" with an emphasis on the peaceful transition of power, establishing the Asia Infrastructure Investment Bank (AIIB) using Western (mostly American) standards, and expressing the willingness for cooperation on climate governance. As the other measures failed to deliver, climate change rose quickly to the top of China's international agenda. Striking a climate deal became the new point of cooperation to avoid dangerous decoupling and escalation with the United States.

Explaining China's Changing Attitude

The economic "new normal" and domestic climate policies

Existing explanations have typically argued that an international treaty is adopted by a country driven primarily by domestic political and economic interests (Putnam 1988). Such explanations were found in most works on China's attitude toward any international climate regimes. It was believed that China is hostile to international climate treaty because it threatens the carbon-intensive development path (Christoff 2010; Conrad 2012). For a country with 97 percent of energy endowment coming from coal, it was the only safe and feasible fuel option for China to power its growth. Therefore, as China's economy averaged double-digit growth

from 1981 to 2010, over the same period, coal consumption rose from 1.36 billion tons to near 4 billion tons, at an average annual rate of 12 percent. The carbon-intensive construction and manufacturing industry has been the engine of the nation's economic growth since the economic reform(Stern 2011). Its growth rate averaged 12.6 percent from 1991 to 2010. The high growth corresponds to the rapid urbanization and industrialization driven by massive export (Zhu and Peng 2012). Despite gradual declines owing to rising oil and hydropower consumption, it has still managed a 70 percent share by 2010. For China, decarbonization and mitigation were understood as economic slowdown and loss of competitiveness. Scholars and China observers believed that such concerns were the main drivers behind China's hostility toward a binding emissions cap.

In addition, the Chinese government has recognized the importance of renewable energy (Li and Wang 2012), listing it in the *Made in China 2025* as one of the primary drivers of the innovation-oriented economy.[2] China's investment in renewables grew accounted for one-third of global investments in renewable energy in 2015. As a result, China's renewable energy consumption increased steadily over the past two decades, representing 10 percent of its total energy usage in 2015. Echoing the 15 percent target of non-fossil energy in 2020 under the Copenhagen Accord, the 12th FYP of Renewable Development set the installation target at 121 GW with at least 220 billion kWh electricity from wind and solar by 2015, and aims to boost their installations to 250 and 150 gigawatts, respectively, by 2020.[3] Therefore, signing the international climate agreement was aligned with its economic reality and domestic policy agenda (Hilton and Kerr 2016).

Although domestic economic conditions and energy policy have been considered the drivers of China's support of the Paris Agreement, this argument is insufficient for explaining the timing and level of priority of the climate agreement. First, the economic "New Normal" argument does not provide a satisfactory explanation of China's change in diplomatic behavior. The economic "New Normal" reflects a long-term trend of development pattern that originated as early as 2010. Such continuous factor has limited explaining power for explaining a sudden diplomatic change that took place in 2014-2015, because it endures a much longer time frame than the change of China's role in the climate agreement.

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[2] The State Council of China. *Made in China 2025,* May 8th, 2015. http://www.gov.cn/zhengce/content/2015-05/19/content_9784.htm

[3] NDRC. 12th FYI for Renewable Energy Development. June 2012. https://policy.asiapacificenergy.org/sites/default/files/12th%20Five%20Year%20Plan%20of%20Renewable%20Energy%20Development%20%28CH%29.pdf.

Second, the economic slowdown could be a double-edged sword for climate change. Because emissions control could also harm the economy in the short run, a fair counterargument is that China could have become even more hesitant to commit to a climate agreement under the economic "New Normal" because pledging absolute emissions control would restrict China's option of stimulus economic policy. In fact, China did experience a coal investment surge in response to the economic slowdown in 2015-16. In other words, the "New Normal" does not necessarily make China commit to an emissions cap.

Third, most importantly, the Chinese leadership did not fully comprehend the consequence of the "New Normal" until mid-2016. In an article published in the People's Daily in May 2016, allegedly authorized by vice-Primer Liu He, Xi Jinping's chief economic advisor, the central government signaled that the current economic slowdown is here to stay.[4] He stated that China's growth prospect would follow a "L-shape" pattern instead of an "U or V-shape" one. This statement indicates that the Chinese leadership finally come to an agreement about the future of China's economy. Chronologically, such a consensus happened two years later, and thus could not be the cause of China's decision on climate change that was made no later than mid-2014.

Fourth, even though the Chinese government emphasizes the importance of renewables, coal is still deemed the "cornerstone" of energy security and economic development.[5] Coal interest groups and associated regulators have higher status among the state-owned enterprises and in the bureaucratic system. This paradox is better illustrated by the dynamics between coal and renewables in its energy system. While China's statist approach successfully facilitated a strong wind and solar industry and made China the front runner in renewable installations and generation (Chen and Lees 2016; Dai and Xue 2015; Liu and Shiroyama 2013), such development is crippled by the lacks of systematic integration and across governmental cooperation, causing significant renewable curtailment (Dong et al. 2018) and over-investment in coal-powered capacity (Yuan et al. 2016).

In sum, China's domestic economic and political factors are at best necessary condition, but insufficient for explaining its proactive role in the making of the Paris Agreement. In the

[4] The prospect of the economy was seriously debated in the CCP. Party economists provided different opinion regarding the future of China's growth. This article on People's Daily was believed to signal that the CPP leadership has reached a consensus about the economy. People's Daily. *Authority on Chinese Economy*. May 6, 2016, http://opinion.people.com.cn/n1/2016/1206/c1003-28929640.html.

[5] This claim is repeatedly appearing in many important energy policy documents. For instance: National Energy Administration. "Notification on the Security of Coal Supply During the COVID-19 Pandemic." Feb 2, 2020. http://www.gov.cn/zhengce/zhengceku/2020-02/04/content_5474546.htm.

next section, using detailed process tracing and interviews with key decisionmakers, I provide evidence to support the realist argument that concerns about the worsening U.S-China relations lie at the center of China's role in global climate governance. After trying different strategies, in 2014, China found that cooperation on climate change was the only common ground for meaningful cooperation between China and the United States. China thus decided to play a more proactive role in the making of the Paris Agreement to mitigate the risk of conflict with the United States.

Cultivating Climate

As summarized above, the turning point in the making of the Paris Agreement occurred in November 2014, when China decided to sign the joint statement with the United States, following with other significant parties. This shift was surprising to the international community, given China had been refusing to make any climate pledge with absolute emissions control since 2009.

What caused the climate issue to rise up in Xi Jinping's international agenda in 2014 and eventually made the Paris Agreement happened in 2015? As discussed above, neither domestic economic restructuring and climate relevant policies, nor the influence of international communities were able to explain the policy change in COP 21. China's economy has been slowing down since 2011, and domestic energy and climate policies have been initiated since the mid-2000s. Nor were the authoritarian leadership suddenly persuaded by international climate negotiators, environmental INGOs, or academic community participated in COPs and IPCCs.

I argue that to explain China's decision to engage in global climate governance, we need to place U.S.-China relations at the center of international climate politics. As in 2014, tension and distrust between the United States and China have risen to a historical level since 1989. The two countries cannot reach any meaningful agreement in almost all issue areas, including trade, technology transfer, intellectual property protection, constraints on FDI, cybersecurity, human rights, and the South China Sea. Climate change was the only issue area left for meaningful cooperation that the two countries desperately needed for managing their growing cleavage. Domestic energy and climate policy and the economic "New Normal" only made it the cheapest option for China to compromise at the time.

The Rising tensions

Since the 2008 Global Financial Crisis, the international political and economic power structure has shifted in Beijing's favor. The United States found itself in a position that increasingly needs China's cooperation or to remain neutral for dealing with essential issues in international relations (Indyk, Lieberthal and O'hanlon 2012). According to Jeffrey Bader, Obama's chief Asian Affairs advisor on the National Security Council, from 2008-2011, the following issue areas were the priorities in U.S.-China relations:[6] on the global economic front, President Obama demands China's contributions to accelerate global economic recovery; on the security issue, Obama needs China's cooperation and join the UN security council condemnation to prevent nuclear proliferation in North Korea and Iran; on global climate governance, as discussed above, the United States cannot achieve anything significant without the cooperation from China.[7] However, cleavage and distrust between the two countries on both economic and security issues have increased in the following years as the power structure continues to change.

First, on trade and economy, tensions between the US and China increased as the world economy recovered from the financial crisis. At the G20 Summit in 2009, U.S. attention shifted to international trade imbalances resulting from China's stimulus package in 2008-2009 and fixed currency rate. China's undervalued currency quickly rose to the center of the grievance. The United States was worried about China's growing trade deficit, caused partly by the under-valued RMB.[8] Furthermore, the U.S. government was alarmed by China's new strategy for economic and technology development. According to the U.S. Congressional Report, China's strategy involved state investment, subsidies, business espionage, forced technology transfer in exchange for market entrance, and domestic market protectionist measures.[9] These alleged behaviors not only challenged the U.S. government, but also antagonized America's business communities. According to Indyk, Lieberthal and O'hanlon (2012), the business community, which traditionally advocates for stable US-China relations, as becoming increasingly

[6] Conversation with Jeffrey Bader.

[7] According to Bader, President Obama was very determined to cooperate with China on climate change. He bought up this issue many times during with meeting with President Hu. For more details about the episode in Copenhagen, please also refers to chapter 6 in *Obama and China's Rise: An Insider's Account of America's Asia Strategy* by Jeffery Bader.

[8] According to Jeffery Bader, President Obama sees China's currency manipulation the key element for America's trade deficit and unemployment issue, and thus repeatedly raised this issue in his meeting with President Hu Jintao.

[9] United States Trade Representative, "2013 Report to Congress On China's WTO Compliance.", December 2013, https://ustr.gov/sites/default/files/2013-Report-to-Congress-China-WTO-Compliance.pdf

disappointed about the prospect of the Chinese market, partially due to protectionism, lack of intellectual property protection, and force-technology transfer.

China, on the other hand, was alarmed by America's moves because they would damage its economy and the Party-state's agenda for "the great rejuvenation of the Chinese nation." For many Chinese, the optimal goal of the United States is to prevent China from surpassing it in terms of economic and technology development, maintaining its hegemonic status. For instance, raising RMB's value as the United States requested would have decreased China's export competitiveness and devalued its foreign currency reserves and U.S. treasury securities, of which China is the largest holder of both. Meanwhile, China believed that the United States was building an international alliance to contain China economically. Specifically, the United States-led Trans-Pacific Partnership (TPP) aims to form the largest international free trade zone that was deliberately designed to by-pass the WTO and contain China.[10]

Second, in terms of security, distrust between the United States and China has never been resolved. Thinking of US-China relations under the logic of great power competition is popular in China. Many believe the United States is using every strategy to contain China, and even overthrow the Communist regime if necessary. In the wake of the Arab Spring in 2011, President Obama expressed strong support and willingness to promote democracy and human rights in Asia.[11] This global democracy agenda was consistent with domestic political forces in the State Department and the Pentagon, who argued for adopting a stronger stand on human rights and security issues (Indyk, Lieberthal and O'hanlon 2012). Especially after James Steinberg and Jeffery Bader left the White House in early 2011, the Obama administration adopted tougher lines on relevant issues.[12] As a result, China worried that the United States aimed to contain China by directly facilitating a democratic revolution.[13] Such distrust reached on historical level when Ambassador Jon Huntsman Jr. appeared in-person on the site of a planned pro-democracy protest in Beijing in 2011.[14]

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[10] Yang Yu, "Can the TPP Contain China's Economy?" *Xinhua Net*, October 6, 2015, http://www.xinhuanet.com/world/2015-10/06/c_128293600.htm"

[11] Kenneth G. Lieberthal, "The American Pivot to Asia." *Brookings Institution*, Dec 21, 2011. https://www.brookings.edu/articles/the-american-pivot-to-asia/.

[12] Lieberthal, Ibid.

[13] Xinhua Net, "American plot behind the Middle East Chaos," Feb 24, 2011. https://world.huanqiu.com/article/9CaKrnJqna2.

[14] Although the U.S. government claimed that Huntsman accidentally came across the event while out shopping in a mall nearby, the Chinese were not persuaded. See: https://www.pri.org/stories/2011-02-24/chinese-web-attacks-us-ambassadors-presence-jasmine-revolution.

Third, as distrust between China and the United States continued to grow, unconventional security, particularly cybersecurity, has quickly become a new dominant issue area.[15] Americans believed that China was behind the increasing number of cyber-attacks targeting U.S. companies and institutions, while China worried about its venerability when facing attacks from the United States, because of its poor cyber defense system and U.S. controlled software (Lieberthal and Singer 2012). In sum, since 2011, tensions and differences between the United States and China were widening as areas of cooperation shrank.

Risk management and climate change

The Chinese leadership was fully aware of the risk of decoupling between China and the United States. After Xi Jinping assumed power in 2013, China adopted several (failed) attempts to manage tensions while pushing its new proactive international agenda as a rising power.[16] First, China promoted the so-called "New Model of Great Power Relations" to describe U.S.-China relations. In his first state visit to the United States as Chinese President at Sunnylands in 2013, Xi Jinping stated the three core concepts of the "New Model," namely, neither conflict nor confrontation, mutual respect, and mutually beneficial cooperation in areas of mutual interest. Although the "New Model" was loath by the Obama Administration (and thus was soon abandoned by China after 2015),[17,18] avoiding conflict and confrontation was listed as the top priority.

Second, China recruited a highly internationalized team, which includes a group of distinguished American lawyers, experts, and scholars, in the design and management of the Asia Infrastructure Investment Bank (AIIB) to ease the suspicion and criticism of the United States. From 2013 to 2015, Beijing contended that the AIIB will be a signature multilateral institution that complements the World Bank and the Asian Development Bank (ADB), though the United States expressed strong criticism on the initiative and urged its allies not to participate. In 2015, then designated president of AIIB, Jin Liqun, a renowned former senior officer at the World Bank and ADB, told the audience in Washington that the AIIB would be

[15] Interview with Susan Thornton.

[16] Here, of course, are not to say that China was willing to backdown on any of the major issue arenas and go back to Deng Xiaoping's "hide the talent and wait for the time." It means China was carefully crafting its proactive international policies while attempting to avoid confrontation with the United States.

[17] David Wertime, "China Quietly Abandoning Bid for 'New Model of Great Power Relations' With U.S." March 2, 2017. https://foreignpolicy.com/2017/03/02/china-quietly-abandoning-bid-for-new-model-of-great-power-relations-with-u-s/.

[18] Cheng Li and Lucy Xu, "Chinese Enthusiasm and American Cynicism Over the 'New Type of Great Power Relations'." Dec. 4, 2014. https://www.brookings.edu/opinions/chinese-enthusiasm-and-american-cynicism-over-the-new-type-of-great-power-relations/.

operated and managed consistent with the highest possible standards, including environmental and human right standards that were followed by the World Bank and the ADC.[19] He insisted that the AIIB is always open to Americans.

Even though China is well aware the importance of climate change in Obama's global agenda, the new Chinese leadership did not place climate change as a priority in the bilateral relations. In their first meeting at Sunnylands, Xi Jinping expresses cooperative intention with the United States on climate change. Yet, he did not soften his stance on the idea of "common but differentiated responsibilities," and made no pledge on absolute emissions control. The area of climate cooperation was limited to clean energy. In the joint Presidential Remarks after the bilateral meeting, Xi Jinping insisted on using "energy and environment" instead of "climate" to address relevant topics in bilateral cooperation.[20] This once again indicated that Xi Jinping's position on climate change was consistent with his predecessor.[21] The change in leadership did not change China's stand on climate issues.

Despite managing tensions with the hegemon was in on his political agenda, in the following two years after Xi Jinping became the President of China, he found China and the United States to have deep cleavages in all of the abovementioned major issue areas: on trade and intellectual property, the negotiations had stagnated; on cyber security, fundamental differences on the definition of national security information remained; [22] on nuclear proliferation, China's influence on North Korea was too limited to reach Obama's expectation;[23] neither was the United States interested in any re-definitions of the bi-literal relations nor participating in the China-led multilateral institutions (the Belt and Road Initiative and AIIB).

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[19] For the full transcript, see: "Building Asia's new bank: An address by Jin Liqun, president-designate of the Asian Infrastructure Investment Bank." Brookings Institution, October 21, 2015. https://www.brookings.edu/events/building-asias-new-bank-an-address-by-jin-liqun-president-designate-of-the-asian-infrastructure-investment-bank/.

[20] The White House, June 08, 2013. https://obamawhitehouse.archives.gov/the-press-office/2013/06/08/remarks-president-obama-and-president-xi-jinping-peoples-republic-china-.

[21] In fact, experts would say Xi inherited Hu's overall foreign policy orientation. See Rush Doshi, "Hu's to blame for China's foreign assertiveness?" *Brookings*, January 22, 2019, https://www.brookings.edu/articles/hus-to-blame-for-chinas-foreign-assertiveness/.

[22] According to Susan Thornton, the United States and China have very different understanding of national security information. China defines national security sensitive information in a much more border way comparing to the United States.

[23] Ambassador Cui Tiankai openly admitted that it was a "mission impossible" for China to simply persuade North Korea to give-up its nuclear weapon on the behest of the United States. See: https://www.usip.org/events/us-china-cooperation-peace-and-security-ambassador-cui-tiankai.

More importantly, on the East and South China Sea issue, the most significant achievement was two memoranda of understanding (MoU) on maritime, and air encounter for avoiding unwanted confrontation, fundamental differences between them remain salient. According to both Bader and Thornton, the South China Sea issue has significant negative impact on people's attitude toward China, especially among the foreign affairs community.[24] As described by Susan Thornton:

> The whole [South China Sea] issue indicates that China was unwilling to accept international rule… it was a turning point, more than anything else, alarms the military community about China true intentions and military buildup.[25]

As the result, tensions and distrust between the two nations have never been greater since 2000, and the area for cooperation has never been so small. Given the existing power structure, China certainly had higher stakes in a healthy bi-literal relation. China was eager to find an area of interest with the United States to ease the tensions and cultivate cooperative relations. China expert on elite politics confirms that the stakes were also high for Xi Jinping personally, because he had to show his diplomatic capability by striking a deal with the hegemon (Li 2016).

Climate change thus become the only common ground of interest left for both countries. According to Bader, the Chinese government was fully aware of the importance of climate change on President Obama's political agenda by 2009, but still reluctant to change its official position.[26] As the other risk management measures failed to deliver positive results, climate change quickly rose to the top of China's diplomatic agenda. In February 2014, Xi also stated his strong support for climate governance for the first time in his meeting with John Kerry later of the month.[27] Xie Zhenhua told the United States delegate that such a deal might not be made until 2015, even though his American counterparts were pushing for an earlier joint announcement.[28] Also, at that time, China had not yet provided any details about the deal it was willing to make, both on or off the record[29]. When it became clear in late 2014 that other

[24] Bader, Ibid.
[25] Thornton, Ibid.
[26] Bader, Ibid.
[27] https://2009-2017.state.gov/secretary/remarks/2014/02/221658.htm.
[28] More details about the mission, please see Jeff Goodell's article on the meeting: "The Secret Deal to Save the Planet" *Rolling Stone*, December 9, 2014, https://www.rollingstone.com/politics/politics-news/the-secret-deal-to-save-the-planet-57275/.
[29] Jeff Goodell, Ibid.

risk management strategies have failed,[30,31] the weight of a successful climate deal increased considerably, for both U.S.-China relations and Xi Jinping. In just two weeks before Xi and Obama's meeting on APEC in Beijing, China finally softened its previous defensive position on the "carbon emissions right" and inclined to cap carbon emissions.[32] Xie Zhenhua reached out to Todd Stern and John Podesta and delivered a critical number: a carbon emissions cap in around 2030.[33] China and the United States finally had a joint statement on climate change to announce in November.

During the whole course of 2015, China joined hands with the United States to push forward bi-lateral statements with other significant partners around the world. By the opening of COP21, both the United States and China had reached bilateral agreements with France, Germany, Russia, India, Brazil, United Kingdom. Together this group represented over 70 percent of global carbon emissions. At the COP 21 conference, mutual trust between the United States and China reached a high level. Diplomats from both countries collaborated closely in striking a multilateral climate treaty, which was built on their landmark Joint Announcement in November 2014. As some Chinese climate negotiators revealed:

> There are many bilateral negotiations in the multilateral platform…two teams sat down in a 'black room' and mainly discussed the differences between developed and developing countries…and reach some agreements on some parts of the main texts of the treaty…Objectively speaking, China made many joint announcements with other countries, but they are not as important as the U.S-China Joint Announcement…because it set the principles for many issues…you can easily find the trace of U.S.-China and France-China Joint Announcement in the final draft the Paris Agreement.[34]

The high level of mutual trust and the cooperation between the United States and China could also be illustrated by a dramatic event toward the end of the climate conference in Paris. The incident happened when a proposed UN deal delivered to the Submit one day before the end of the COP 21 using the legally binding 'shall' instead of a semi-binding 'should' when

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[30] Cheng Li and Lucy Xu, Ibid.
[31] Not only did the United States show no interest in joining the AIIB, but it also openly against other countries for joining it. See Zachary Keck, "Why the US Is Trying to Squash China's New Development Bank," October 2014. https://thediplomat.com/2014/10/why-the-us-is-trying-to-squash-chinas-new-development-bank/
[32] Interview with senior Chinese climate negotiator.
[33] Chinese climate negotiator, Ibid.
[34] He Jiankun and Teng Fei, "The Paris Climate Summit and its Implications for China: Insights from Chinese Negotiators in Paris" *Brookings*, December 21, 2015. https://www.brookings.edu/wp-content/uploads/2015/12/Transcript-20151221.pdf.

describing developed country obligations, a word that the United States carefully tried to avoid so that the Paris Agreement would not have to go through the U.S. Senate. However, at the time, all delegates were eager to reach a deal. The United States' request for modification was challenged by many developing countries, some of whom were under the suspicion that the United States added the typo deliberately for dodging obligation and avoiding blame in the future. Secretary of State John Kerry immediately reached out to the Chinese delegate, asking China to back the United States and persuade the developing nations. After a series of bi-literal and multilateral deliberations, all parties in Paris the past the desired treaty on time.[35] As a climate observer commented: "Whatever the origin of the mistake – if it was a mistake – the outcome demonstrated how close China is to the US that it was willing to bail it out.[36]"

The making of the Paris Agreement considerably eased the tensions between the two countries. Cooperation on the international stage cultivate friendship between diplomatic personals. For instance, Todd Stern, top U.S. diplomat on climate change, commended on his friendship with his Chinese counterpart Xie Zhenhua:

> China and the United States has tremendous differences since the beginning of climate negotiations…making it difficult to make a compromise on many issues… and sometimes even lead to conflict. But we learned to deal with each other over the years, and figure out where each other's 'red line' is…We [Stern and Xie] become good friends over the years…I invited him [Xie] to my house for dinner when he visited the United States.[37]

In their leaked email exchange, Stern and Xie agreed that the model of US-China cooperation on climate "should be carried forward in other areas in the bilateral cooperation."[38] Todd Stern wrote that the future of U.S.-China relations has turned to a more cooperative and mutually beneficial direction, all made possible by climate diplomacy.[39] John Podesta, the former senior officer in the Obama Administration, was also deeply engaged in the negotiation processes. His involvement in the Clinton Campaign and perhaps a Clinton White House would presumably carry the cooperative climate into the next administration. In addition, China also

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[35] He Jiankun and Teng Fei, Ibid.
[36] Ed King, "China rescues US from Paris climate deal 'typo' fiasco." *Climate Home News*, December 12, 2015. https://www.climatechangenews.com/2015/12/12/china-rescues-us-from-paris-climate-deal-typo-fiasco/
[37] Jing Li, "Xie Zhenhua: China's top climate negotiator steps down." *China Dialogue*, December 9, 2019. https://chinadialogue.net/zh/3/44312/
[38] Ed King, "Podesta email dump reveals tight US-China climate ties." *Climate Home News*, October 2016. https://www.climatechangenews.com/2016/10/19/podesta-email-dump-reveals-tight-us-china-climate-ties/.
[39] Ed King, Ibid.

uses the climate platform to cultivate friendly relations with U.S. government officials outside the negotiation rooms. Both the U.S. Environmental Protection Agency and Department of Energy actively engaged in cooperation with their Chinese counterparts.[40] Those interactions cultivated a friendly climate between government officials from both countries. As former Under Secretary of Energy David Sandalow comments:

> They [the Chinese officials] are extremely friendly… I developed a very close relations with Wan Gang [Minister of Science and Technology] and Zhang Guobao [head of the Energy Bureau]…we engage in very constructive cooperation. I think those interactions are very positive for US-China relations.[41]

U.S.-China climate cooperation from Trump to Biden: a counterfactual analysis

The fallout of the United States-China relations during the Trump era provides a good opportunity for counterfactual analysis. Without climate change as an anchor for cooperation, the bilateral relation has become notoriously toxic. The accumulated disputes on trade, intellectual property, technology, human rights, and the South China Sea have quickly escalated to a dangerous level, significantly increasing tension between the hegemon and the rising power. The Trump administration started a series of trade wars and imposed strict sanctions on China's flagship informational technology companies. While China still has an incentive to deescalate tensions, Trump's "America First" policy orientation gives the two countries barely any room for international cooperation.[42] China eventually decided to compromise on trade negotiations and reach a deal with the Trump administration by late 2019. However, in the wake of the COVID Crisis, tensions between China and the United States further escalated, and toxic exchanges emerged one episode after another. Tensions reached an all-time high after the United States closed China's Houston Consulate-General. The United

[40] Interview with Susan Thornton and David Sandalow.
[41] David Sandalow, Ibid.
[42] During the early Trump presidency, China tried to continue collaboration on energy trade, especially LNG import from the United States. For more details, see *U.S. gas to China: Positive energy for bilateral relations*, by Jiaqi Lu and Ye Qi, https://www.brookings.edu/2018/05/31/u-s-gas-to-china-positive-energy-for-bilateral-relations/ and *Demystifying U.S.-China Energy Trade*, by Jane Nakano, https://www.csis.org/analysis/demystifying-us-china-energy-trade .

States Secretary of State Mike Pompeo abandoned the political stance adopted by the United States since Nixon, openly called for regime change in China.

As climate change was taken off the U.S. political agenda, China also lowered the political importance of climate change to avoid the sucker's payoff. In the State Council institutional restructuring of 2018, the authority of climate negotiation was re-assigned from the National Development and Reform Committee (NDRC) to the Ministry of Ecology and Environment, which is a much lower ranking ministry than its former home department, and no former experience on climate governance. Such an institutional arrangement hinders the credibility and effectiveness of China's international climate cooperation.[43, 44]

The downplaying of climate change was also reflected in the policy outcome. In 2018, China relaxed some of its policies made in 2016-2017 that restricted coal power plant constructions,[45] giving green light to coal projects at the provincial level and releasing near 30 GW coal power units from 2018 to mid-2020.[46] The resurgence of coal power plants has seriously threatened China's mitigation potential and its ability fulfilling its climate pledge. Meanwhile, China was also pushing coal globally through the BRI. The share of coal investment in all energy related projects increased from 18 percent in 2016 to 40 percent in 2019 (Figure 1). The resurgence of coal investments, both domestic and international, have seriously threatened China's mitigation potential and the credibility of its climate ambition.

[43] In my interview with John Holdren, U.S. former senior official in the Obama administration, he expressed concerns about how little the head of the MEE even knows about climate change.
[44] See Li Jing, "China's new environment ministry unveiled, with huge staff boost." *Climate Home News*. April 09, 2018. https://chinadialogue.net/en/cities/10599-china-s-new-environment-ministry-unveiled-with-huge-staff-boost/.
[45] Feng Hao, "China is building coal power again," *China Dialogue*, September 28, 2018. https://chinadialogue.net/en/energy/10761-china-is-building-coal-power-again/.
[46] See Global Carbon Monitor, June 2020. https://globalenergymonitor.org/wp-content/uploads/2021/01/A-New-Coal-Boom-in-China_Mandarin.pdf.

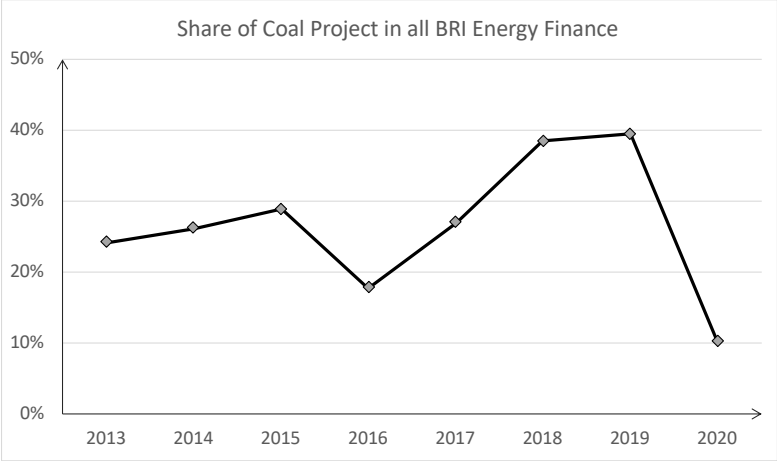

Figure 1. Share of coal in all energy finance through the BRI.[47]

In 2020, however, the global pandemic created an exogenous shock on international environment, significantly intensifying China's relationship with the United States and the West. Therefore, the global pandemic could be understanded as an external shock that increased the likelihood and cost of political confrontation. The risk management model implies that if such a shock is large enough, China might be willing to cooperate even if the U.S. defects in exchange for de-escalation. As the theory predicted, in September, China updated its climate pledge, resetting emissions peak to before 2030 and announced carbon-neutral pledge by 2060,[48] only ten years after Europe. In other words, China, the world's largest energy and coal consumer will eliminate fossil fuel consumption in just 40 years. The new climate pledge is deemed overly ambitious by many energy experts.

After Biden won the White House, climate change quickly become one of the top priorities in America's international political agenda. President Biden named the former Secretary of State, John Kerry, in charge of the global climate negotiation. In response, China recalled its climate veteran Xie Zhenhua, who was retired after 2015, to head the climate negotiation team.[49] Under Xie's leadership, the NDRC and the MEE put together a join climate task force for climate actions and negotiations. Xi Jinping himself even willing to publicly commit to stop building coal project overseas in September 2021. These new developments once again signal

[47] Data source: China's Global Energy Finance, Global Policy Development Center, Boston University.
[48] This announcement caught the fossil fuel interest groups, bureaucrats, and many energy experts completely off-guard. One evidence is that China's 14th FYP, which was first drafted in mid-2020, did not mention carbon neutrality at all. When it was released in March 2021, the FYP received many criticisms for not incorporating the carbon neutrality goal into the plan. This once again prove that China's domestic politics have little effect on the decision for climate cooperation.
[49] This appointment is rare in Chinese politics because of the strict mandatory retirement age requirement at age 65, and Mr. Xie is 71 in 2021.

that the Chinese government is willing to cultivate a cooperative relationship with the United States on global climate governance.

Discussion

Based on the empirical analysis, this section summarizes the implication of the reassurance strategy. The rising power should design reassurance measures to produce desirable great power relations in the near future, which include efforts to reduce conflicts, to cooperate or at least work in broadly parallel fashion to provide regional and global public goods, and to facilitate mutual bilateral benefits. In general, a reassurance measure should fulfill the following criteria.

First, considering the risk of tension escalation and misjudgment (Goldstein 2013), the risk management measure should be able to ease tensions in the short run. The core benefit of risk management measure is that it demonstrates the rising power's intention to cooperate with the hegemon under the existing international order. As such, the risk management measure should be adopted in a timely manner to resolve immediate threats of crisis instability and control the opportunity cost of further escalations. It should be able to ease tension immediately. For the hegemon, not every issue area is weighted equally. To resolve the tensions, the rising power should offer cooperation for issues that the hegemon prioritizes at the time, not for marginal issues ranked low in the hegemon's political agenda.

Second, the measure should be considered credible to the hegemon. This is especially important for the hegemon because only credible commitment has binding effects that can ensure the rising power to cooperate in the second round. A less credible commitment has limited effects on the likelihood of confrontation comparing to a credible commitment that can bind the rising power's behavior in the future. To make the reassurance measure credible, actions are more conceivable and less ambiguous than rhetoric or easily revisable statement. If the rising power merely uses rhetoric or revisable statement, then the hegemon might not consider it credible, instead of viewing them as time-biding tricks, which might fail to lower tensions. In this regard, participating in formal international institutions could create significant international audience costs associated with non-compliance behavior, serving a credible commitment device (Keohane 2005; Tomz 2012), even for non-democracies (Fang and Owen 2011).

Third, such a measure should also be sustainable and able to encourage future cooperation. To facilitate stable long-term engagement, the rising power needs to establish a routinized or even institutionalized platform for dialogues and cooperation that goes beyond a particular topic in the given time (Lieberthal and Jisi 2012), and should have positive feedbacks for other issues and risk-management measures in the future. In light of the two countries are talking to each other, the rising power might be able to settle down on a deal with the hegemon, avoiding immediate losses from its assertive policy.[50,51]

For the hegemon, cooperation on international public good provision does not mean it must become friendly with the rising power. As the power transition theory indicated, the treat of serious competition or even conflicts could still exist in between the bilateral relations to impost a cost for defection. As long as the hegemon is willing to up-hold the existing liberal world order, the rising power would be willing to comply if the benefit of cooperation excesses the consequences of defection. Peace and cooperation for global commons can be achieved even if a potential conflict is on the long-term horizon.

Conclusion

This research shows that simply attributing China's diplomatic behaviors to domestic factors is insufficient in explaining China's proactive role in climate negotiations. I argue that the need to manage tensions with the United States by cultivating a cooperative climate was essential to understand China's sudden change of attitude toward a semi-binding climate agreement. When dialogs with the United States on trade, security, and human rights issues were stagnated, climate change rose quickly to the top of China's international agenda. Striking the climate deal became a new area of cooperation to avoid dangers decoupling and escalation with the United States. If the two countries engaged in cooperative dialogue, the risk of distrust and misjudgment is manageable.

These findings contribute to the literature on great power politics and U.S.-China relations, as well as climate governance in several ways. Specifically, I believe this analysis describe a more realistic picture of great power relations in the age of globalization: *when we take global*

[50] Cheng Li, ibid.

[51] Paul Haenle, *Building Strategic Trust in the United States-China Relationship*. November 6, 2014. Carnegie Endowment for International Peace. https://carnegietsinghua.org/2014/11/06/building-strategic-trust-in-u.s.-china-relationship-pub-57162.

threats seriously, even if we accept the pessimistic realist assumption that conflict is inevitable between the great powers, there is still ample reasons for cooperation. Even during the high noon in the Cold War, the United States and the Soviet Union cooperated to eliminate the smallpox, marking a historical success of global health governance. Today, avoiding a global scale climate catastrophe requires far more comprehensive and long-lasting cooperation than that in the 1970s. Deviation from cooperation will not benefit neither party, at least in the long run. Scholars specialized in should further sophisticate the realist IR theory by taking the threat of other global crisis (such as a global pandemic) into account.

The chapter also demonstrates that China's decision to play a leadership role on climate governance goes beyond the narrative of domestic politics. Reassurance is central to China's rationale for striking a binding climate agreement with an emissions cap. For growing powers such as China, reassurance efforts within the existing international order can be an effective way to ease the tensions with the hegemon. Cooperation with the United States on issues of high-importance manages the risk of confrontation in both near- and long-term (Lieberthal and Sandalow 2009).

Under the current political climate, it is hard to foresee the prospect of US-China climate cooperation in the future. Even after the United States comes back to the climate table under the Biden Administration, the United States and China still must navigate troubling water of worsening mutual distrust and antagonism that rooted much deeper than just four years ago. Once again, both U.S.-China relations and the fate of global climate governance are at a crossroads: if the bi-literal relations remain locked in a toxic zero-sum confrontation, it is possible that their actions will eventually lead to a global climate catastrophe, if not an armed collision between two nuclear great powers.

Chapter 4

Networking for the Climate: Policy Actors in Beijing

Introduction

On a steamy day in the late summer of 2001, the former vice-Premier and head of the National Development and Reform Committee (NDRC), Zeng Peiyan, and his deputy director Zhang Guobao received a surprised phone call from Zhongnanhai. On the other end of the phone, a confident voice with a subtle Yangzhou accent asked: "Why hasn't it been reformed yet?" The voice belonged to Jiang Zemin, then the former Chinese President. "Tell me the truth, what's holding it back?" he asked again, "Where do the disagreements lie?" Zeng knew exactly what the President was asking. It concerned Chinese energy reform, an ongoing major energy sector restructuring that began in 1998 and had been at a standstill for over two years. The 1998 energy reform aimed to increase efficiency by encouraging competition and marketization. The Chinese government abolished specialized energy departments, such as the Coal Ministry and the Electric Power Ministry, adopted from the Soviet Union. It also split the China National Petroleum and Natural Gas Corporation, forming the three major groups of PetroChina, Sinopec, and CNOOC. The government functions of related industries were incorporated into the NDRC, which were later adjusted to relevant coal and petrochemical industry associations. "It all boils down to the future of the entire electricity sector," Zeng said after briefing Jiang with the latest developments. He revealed that ministers, industrial experts, and different

stakeholders disagree on whether to keep all transmission and distribution lines under a single grid or divide them into multiple grid companies. The National Electricity Cooperation even refused to cooperate. Jiang paused for a while, "Compromise," he said in English. [1]

The order from Jiang Zemin set the tone for the reform in the following months. To transition away from the old energy system, the electricity sector reform in 2002 established five principles: (1) separating government function from business, (2) separating power plants from grids, (3) separating main business from auxiliary business, (4) separating transmission from distribution, and (5) competitive bidding for grid connection. Guided by the first two principles, the Chinese government separated power generation from grid operation, dividing the power generation sector into five electricity generation companies (later known as the 'Big Five'). They also encouraged local and private businesses to invest in electricity generation. As a result of the compromise, the transmission and distribution business was divided between the State Grid, inheriting most access of the National Electricity Cooperation and covering 26 provinces, and the Southern Grid Corporation covering five. Yet as another result of the compromise, the other three principles were not closely followed. Researchers and policymakers find these principles critical for China's decarbonization: separating main business from auxiliary business and separating the transmission from distribution are the prerequisite for clarifying transmission costs for renewable electricity; enforcing competitive bidding for grid connection would have facilitated renewable deployment as the price of renewable electricity continues to decrease. A compromise between stakeholders made twenty years ago still haunts China's energy transition today. What exactly happened may be forever unknown except for by a few insiders. Yet it is critical for us to understand the opaque nature of the policymaking process to inform climate actions and facilitate energy transition. Therefore, in this chapter, I seek to see through the foggy Chinese climate politics using network analysis.

Globally, as seen in China and other countries, merely adopting renewable energy does not guarantee the automatic phasing out of fossil fuels (Rentier et al., 2019). Research on the challenges of fossil fuel phaseout focus on a wide range of technological, economic, and political

[1] Zhang Guobao. 2013. Jiang Zeming asked to 'Compromise' in English when Briefed about Electricity Reform. People's Daily. http://politics.people.com.cn/n/2013/0108/c1001-20128623.html.

factors. For instance, evidence shows that historical energy transitions have been slow because the process of transition is predominated by socio-economic factors (Solomon and Krishna, 2011; Sovacool, 2016). Social science scholars commonly view the lack of effective actions as a collective action predicament (Keohane and Victor, 2016; Ostrom, 2009; Stern, 2007) or a zero-sum distributive conflict between different stakeholders (Aklin and Mildenberger, 2020), and ascribe the impediment of fossil fuel phaseout to the inadequacy of political institutions in addressing the issue of free-riding (Victor, 2011) and interest group intervention (Breetz et al., 2018; Brulle, 2022; Jakob et al., 2020; Meckling and Nahm, 2022; Oreskes and Conway, 2011).

Scholarship on the political economy of energy and climate policy focused on the political affordability of energy transitions shed light on the source of divergence between central and local governments. From an economic standpoint, an energy transition is costly, and thus imposes political pressure that discourages climate actions. Previous studies have deemed that politicians in authoritarian regimes, similar to their counterparts in representative governments, tend to prioritize short-term political and economic gain over long-term benefits (Acemoglu and Robinson, 2006; Gonzalez-Ricoy and Rey, 2019). Thus political leaders are reluctant to reduce subsidies for the fossil fuel industry (Martinez-Alvarez et al., 2022; Victor, 2009). Authoritarian leaders face constraints from elite electorates, which often consist of interest groups from the incumbent fossil fuel industry and heavy industry (Brulle, 2022). The pressure of economic growth could also make governments reluctant to transition away from cheaper coal (Kalkuhl et al., 2019). As a result, research finds that the need for a cheap and stable energy supply often outweighs the need to mitigate climate change (Steckel et al., 2015; Wang and Li, 2016). Fossil fuels, especially coal, could be the go to options for energy security and affordability in many countries. Transitioning away could be politically costly for incumbent politicians (Lu and Nemet, 2022; Steckel et al., 2015; Steckel and Jakob, 2022).

Building on the logic of political survival, the understanding of the self-contradicting energy strategy mirrors the political economy of coal versus renewables: even though the Chinese leadership prefers to promote renewable energy, they continue to invest in coal because they have to engage fossil fuel interest groups to keep energy prices low and stable by promoting

the cheapest fuel, i.e. coal. This narrative, however, has four significant shortcomings. First, it assumes the Chinese authoritarian regime has a consistent preference internalization system. Second, it overlooks intricate competition, cooperation, and compromise among different interest groups and social actors within the policy process. Third, this theory ignores the origin of policy preference. Especially for energy and climate policy, politicians often do not possess the expertise and knowledge for effective governance.

In this chapter, I examine how policy actors interact in the energy and climate policymaking process in China. In the context of policymaking, a policy actor is defined as an individual that has the ability to influence the process and outcomes of policy decisions, including government regulators, interest groups, non-government actors, influential scholars, and industrial experts. Even in an authoritarian regime, policy actors can still engage in intensive networking activities. It is often these informal connections that determine the government's knowledge about, and preference for, policy. The policy outcome should reflect the political competition between government agencies and dynamics within the energy industry. This chapter opens two black boxes of the energy and climate policymaking in the authoritarian regime: the internal competition between government agencies and the interactions between regulators and interest groups. Here, I introduce a network approach to preview the opaque nature of authoritarian policymaking. In addition to the government and economic actors, from a practical perspective, I contend that the policy system in China is not a closed loop between politicians and interest groups, but rather, it is open to social and international influence. In the following sections, I first discuss the value of networking in authoritarian regimes, and the formal energy governance structure and actors' incentives for networking activities. I next introduce the network data collection. And discuss my findings on the attributes of the actors and the overarching structure of the policy network. I then seek to identify the most influential figures within the network, based on their structural position, and supplement the analysis with qualitative evidence. Finally, I conclude the chapter and engage in a robust discussion on the findings.

Networking in the Authoritarian Setting

The existing literature on Chinese politics and economics provides solid ground for explaining the dramatic energy transition under the rule of the one-party regime. Scholars contend that Chinese policymaking, especially in energy policy, is characterised by a fragmented and decentralized pattern, highlighting the various forms and impacts of downward power delegation along the bureaucratic hierarchy (Cai, 2008; Lieberthal and Lampton, 1992; Mertha, 2009; Montinola et al., 1995). Even if the CCP central leadership retains a strong capacity to control lower-level cadres (consisting of government officials and senior managers of SOEs) (Chan, 2004; Edin, 2003; Landry, 2008), there still exists a considerable divergence of local actions from central orders (Zhou, 2017; Zhou et al., 2013), undermining the effectiveness of the authoritarian approach to environmentalism (Eaton and Kostka, 2014). The theorization of such divergence reveals that an authoritarian state should also be dissected into the central and the local components, each with its own set of interests and modes of operation, which can align or clash with each other at different times and under different circumstances.

More generally, the research on policy outcomes builds around the logic of political survival. Literature in political economy examines the role of interest groups, particularly in relation to politicians operating within a specific institution, and their efficacy in leveraging political influence to impede climate action (Brauers et al., 2020; Oei et al., 2020; Ohlendorf et al., 2022). Political scientists have identified that a confluence of powerful interest groups, institutional frailties within democratic systems, and bureaucratic arrangements can result in the carbon lock-in effect, thereby impeding the advancement of renewable energy development (Aklin and Mildenberger, 2020; Aklin and Urpelainen, 2018). Stokes and Breetz (2018) contend that new energy technology would challenge the incumbent energy as technological development and economies of scale bring down its cost; the incumbent energy industry would utilize economic and political power to protect its status, slowing down or stopping the transition process. Although both the fossil fuel industry and renewable industry are engaged in political struggle and rent-seeking activities (Burke and Stephens, 2018), the scale of lobbying capacity of renewables cannot match that of the fossil fuel industry. Thus, fossil fuel

interest groups, with their strong capability to utilize both formal and informal institutions to implement their political agenda, have often taken advantage of short-electoral cycles of representative government and successfully lobbied for their business interests at the expense of the interests of society as a whole and of the future generation (Berardo and Holm, 2018). Victor (2009) suggested that upstream subsidies reflect the collective power of small but well-organized interest groups, as their interests are aligned and concentrated enough to bear the transaction costs of lobbying their representatives. Unlike the fossil fuel industry, which has developed a mature supply chain and strong coalition of interests over a very long time, the renewable industry is young and much smaller in scale. Renewable companies are often small and scattered in various places across the country and, thus, often do not have a unified voice. Stokes (2020) concludes that the policy influence of the renewable industry pales into insignificance when compared to that of the longstanding and powerful coalition of fossil fuel firms. Although the relative strength of the fossil fuel industry has declined over time, the persistence of rent-seeking behavior has led to escalated costs of energy transitions, particularly when rapid economic development or recovery is required (Steckel et al., 2015).

To overcome the influence of fossil fuel interest groups, recent studies suggest that energy transitions require policymakers to pay attention to the agency of policy actors, and power structure, as well as the interactions among different power, contingency, and practice for balancing the distributive conflict between fossil fuel interests and climate coalition (Stirling, 2014). Brauers et al. (2020) indicate that the pressure from the international community, particularly the EU, has been a key driver for the coal phase-out in Poland. Lubell and Fulton (2008) find that policy actors can utilize their social capital through networks to influence policymaking. Meckling and Nahm (2022) propose that governments can actively offset the sway of powerful incumbent interests by proactively cultivating their strategic state capacity, through recruiting allies, aligning interests, restricting access, and mitigating the influence of these interests, in order to facilitate climate policy and advance renewable development. Several other research on decarbonization in China also pointed out that socio-economic actors from the industry (Shen, 2017), research institutions and NGOs (Gallagher and Xuan, 2019; Teets, 2018) are very influential in the climate and energy policymaking process.

Building on the aforementioned literature, a realistic model of the policymaking process should involve actors with competing preferences and common grounds coexisting in the policy arenas, and the policy outcomes are reflections of the struggles among, and the resources of, different policy actors. Following the research that confronts the assumption of the internal coherence of the policymaking process in China, this chapter studies the origin of such inconsistency by exploring networking as a preference aggregation process. In particular, I examine the extent to which the structure and governance processes facilitate the development of the renewable energy sector, encouraging a low-carbon transition of the old energy system. I also investigate the dynamics between central and local governments for cultivating the successful renewable industry and dealing with its unintended consequences. I argue that policy networks reveal the struggles and compromises among policy actors by showcasing the complex interactions, relationships, and negotiations among various stakeholders involved in policymaking. Complex and active policy networks provide a platform for both policymakers and non-governmental policy entrepreneurs to engage and advance their interests in the process.

For government policymakers, engaging in networking activities is crucial for staying informed and consolidating political support. Engaging in these activities enables government officials to remain well-versed in the ever-evolving political landscape, policy trends, and emergent issues that may have a bearing on their work or the broader policy environment (Carpenter et al., 2004). Possessing this knowledge is crucial for adapting to shifting political dynamics and ensuring that their policy positions remain pertinent and responsive to the fluctuations in circumstances. Establishing connections with influential stakeholders, such as large investors and reputable scholars, empowers government officials to mobilize political support for their policies and initiatives (Fischer and Sciarini, 2015). This support bolsters efficient policy implementation and enduring policy impact (Lubell and Fulton, 2008). Moreover, by actively engaging with stakeholders and fellow government officials through networking, policymakers can forge strategic alliances and coalitions, which are indispensable for advancing their policy agenda and securing the requisite political support for their undertakings. In summary, the active engagement of government policymakers in networking activities enables them to navigate the complex political environment effectively with better information and stronger political

coalitions, and ultimately achieve more favorable policy outcomes.

For non-governmental policy actors, networking activities play a critical role in collecting information and resource mobilization. In contemporary society, the complexity of governance and interest representation creates strong incentives for stakeholders to establish connections with other groups in order to assess preferences and to gain policy-relevant information (Carpenter et al., 2004). Especially for emerging challengers who are relatively weak compared to established interests, engaging in networking with other informed policy actors enables them to minimize transaction costs and maximize the efficiency of information gathering (Berardo and Scholz, 2010; Carpenter et al., 2004). By exchanging information, insights, and best practices with other stakeholders, they can develop more effective strategies, improve their understanding of the policy landscape, and identify new collaboration opportunities. In addition, intensive networking activities allow policy actors to pool resources, expertise, and political influence, enhancing their capacity to shape policy outcomes. According to the advocacy coalition framework (ACF), actors with shared interests, similar beliefs, and complimentary functionality are more likely to form alliances (Jenkins-Smith and Sabatier, 1994; Lubell, 2007; Zafonte and Sabatier, 1998). Networking activities are essential for building policy coalitions, enabling policy actors to identify potential synergies and partnerships with other stakeholders, thereby enhancing their collective impact on the policy process (Berardo and Scholz, 2010; Henry, 2011; Sabatier and Jenkins-Smith, 1993). By building connections with influential stakeholders, such as direct regulators, senior bureaucrats, senior experts, or others with strong social capital in the field (Henry et al., 2011), policy actors can increase the legitimacy and visibility of their policy proposals and ultimately improve their chances of success.

Actors and their Role in Energy Governance

Studying policy communities using network analysis provides valuable insights into the complex dynamics and interactions among various actors and institutions in authoritarian regimes. This approach can help to reveal the nature and extent of competition between different gov-

ernment ministries and agencies, uncover the intricate connections between different actors within the industrial complex, and shed light on the complex interactions between different interest groups at the ground level. By opening these three black boxes, network analysis can offer a clearer understanding of the power dynamics, rivalries, and alliances that shape policy outcomes, ultimately contributing to more effective policy interventions and a deeper comprehension of the complex political landscape.

Government Actors

In China, climate policy is essentially energy policy. Under the current energy governance structure, the National Energy Commission under the State Council is the highest-level government organization responsible for China's national energy strategy. Established in 2010, the NEC is chaired by the Premier and includes top officials from 22 ministries and agencies involved in energy-related issues. This collective body does not directly determine policies but coordinates grand climate and energy strategy. Among these ministries, three of them are direct regulators of the energy sector:

The National Development and Reform Commission (NDRC): The NDRC holds a half rank above other ministries. Its primary responsibilities include overseeing China's comprehensive development, economic, and energy planning. One of the key roles the NDRC plays in energy and climate regulations is drafting China's national Five-Year Plan. These plans outline the country's economic and social development goals, including specific targets for energy production, consumption, and efficiency, as well as greenhouse gas emissions reduction. The Commission is also responsible for approving energy-related projects, such as large-scale power plants and energy infrastructure development. This ensures that projects align with the country's energy strategy and contribute to the overall goal of promoting energy security and sustainability. In addition, the NDRC establishes benchmark prices for various energy commodities like coal, oil, gas, and electricity across the country. These prices play a significant role in guiding market behavior and influencing investment decisions in the energy sector. Before the 2018 governmental restructuring, the NDRC was also responsible for managing climate policy-making, including establishing the emissions trading pilot program and rep-

resenting China in international climate negotiations. These responsibilities have since been transferred to the Ministry of Ecology and Environment. In addition, the NDRC is also home of the Energy Research Institute, which provides research and intelligence that informs the development of energy and climate policy. The Energy Research Institute (ERI) and other similar government-affiliated public institutions also often take charge of policy drafting.

National Energy Administration (NEA): The NEA is a sub-ministerial government agency administered by the NRDC and responsible for energy and climate-related research and policymaking. Designated for energy regulations, the NEA is responsible for drafting and implementing specific policies, regulations, and industry standards related to the energy sector. The head of the NEA often also serves as the vice director of the NDRC. Compared to other national bureaus overseen by ministries and the NDRC, the NEA has greater regulatory power and autonomy. This allows the agency to efficiently address energy-related issues, adapt to changing circumstances, and drive the implementation of policies that promote sustainable development and energy security.

Ministry of Ecology and Environment (MEE): Formerly known as the Ministry of Environmental Protection, the MEE is responsible for creating, implementing, and coordinating China's environmental policies. It monitors and sets standards for air, land, and water pollution, as well as carbon emissions. Traditionally, the MEE has been a weaker player in energy and climate governance compared to the NDRC and NEA, as it lacks authority over pricing, project approval, or industry rule-making. However, after the 2018 government restructuring, the MEE gained responsibility for international climate negotiations and launching the carbon market, significantly increasing the power of the MEE. The MEE supervises the National Center for Climate Change Strategy and International Cooperation (NCSC, founded under NDRC and transferred to MEE), which provides intelligence support for international climate negotiations.

Moreover, four additional ministries play a supporting role in shaping energy-related policy. The Ministry of Science and Technology (MOST) holds the responsibility for crafting technology and innovation policies, while also directing research funds and subsidies towards

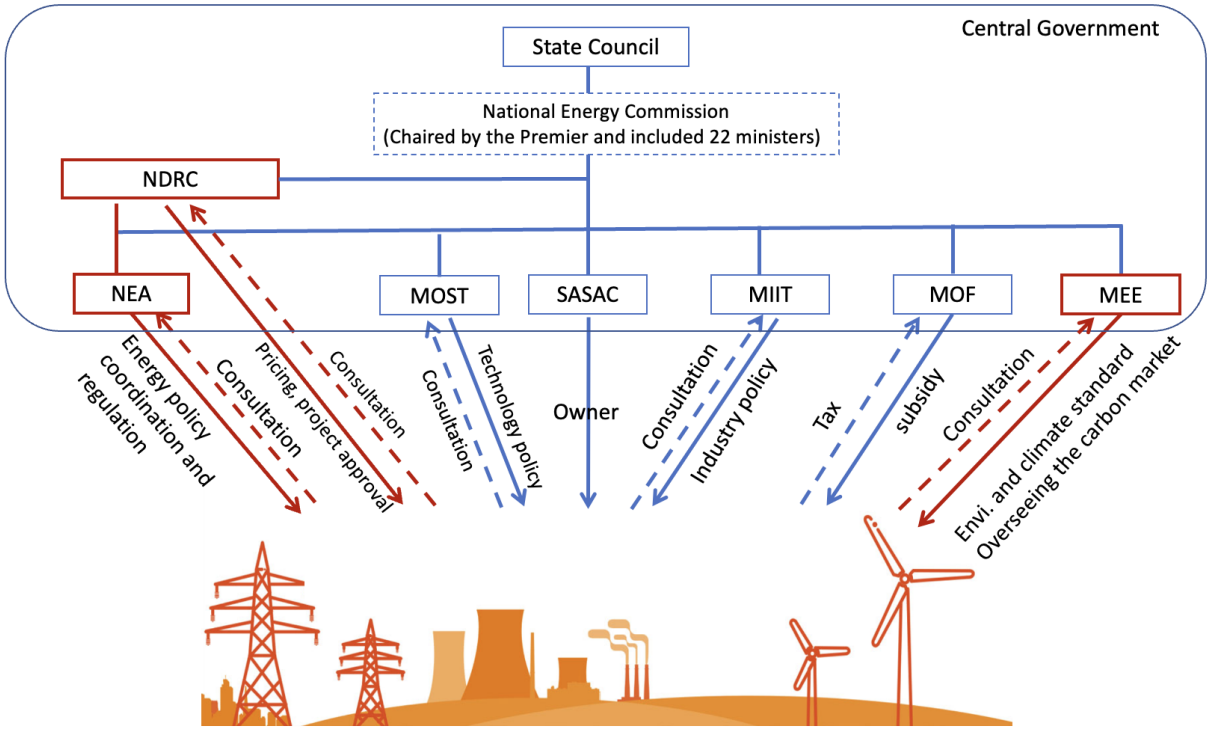

Figure 1: Central Level Energy Governance Structure in China (Source: Author)

the advancement of energy technology development. The State-owned Assets Supervision and Administration Commission (SASAC) takes charge of supervising state-owned energy enterprises, wielding the authority to appoint, evaluate, and remove executives under its jurisdiction. It also has the ability to restructure and reorganize these enterprises to better align with policy objectives and avoid bankruptcy. The Ministry of Industry and Information Technology (MIIT) focuses on industry policies, placing particular emphasis on energy conservation and resource management. Finally, the Ministry of Finance (MOF) plays a crucial role in determining and allocating subsidies across various energy sectors. Figure 1 summarizes the formal structure of energy governance at the central level in China.

Interest groups

The Chinese government maintains control over a significant portion of the energy sector through state-owned enterprises (SOEs). Specifically, SOEs are responsible for approximately 80 percent of total coal production and almost all oil and gas production and distribution. In the electricity sector, SOEs generate about 70 percent of the nation's electricity. The five major electricity companies and six smaller ones owned by the central government (collectively

known as “Big 5 and Smaller 6”) control roughly 60 percent of China’s total installed power generation capacity. Furthermore, two state-owned grid companies oversee all transmission and distribution. Though not directly engaged in policy formulation, some SOEs have substantial influence over energy policy. Many government regulations would require sufficient collaboration from SOEs during their implementation. In some cases, top executives in energy SOEs sometimes hold higher ranks than the government officials responsible for regulating them. A revolving door of top executives and bureaucrats between SOEs and government agencies ensures powerful lobbying influence and generates a conflict of interest for regulators.

While SOEs maintain significant control over the traditional energy sector, the private sector in China was left to explore the blue water of renewable energy, particularly during the early stages of renewable development. Since the early 2000s, newly founded renewable companies actively collaborated with local governments, offering insights and expertise that laid the foundation for supportive industrial policies, which later expanded nationwide. Pioneering firms like Goldwind, Suntech, Yingli, and BYD drove innovation and expanded advanced technologies in wind, solar, and electric transportation, setting the stage for the country’s rapidly growing renewable sector. Their participation helps to promote innovation, mobilize financial resources, and improve policy implementation necessary for achieving China’s energy and climate goals. By participating in industrial associations, advocating for their interests, and showcasing successful projects, private sector companies have significantly influenced policy decisions and created a favorable environment for renewable energy development. Additionally, their engagement in international collaborations has helped to integrate global best practices and drive the adoption of progressive renewable energy policies in China.

Energy business associations, representing SOEs and private stakeholders in different energy sectors, also participate in policymaking. These associations aim to promote the development, cooperation, and growth of the energy industry in China, including renewable energy, fossil fuels, and associated services. They serve as a bridge between the government and the industry and reflect the demands of members and enterprises. While these organizations often register as social groups, the Chinese government exerts a certain level of control

and influence over them, as many are affiliated with or supervised by government agencies. As quasi-governmental organizations, energy business associations collect industry data, conduct research and investigations, propose policy recommendations for energy sector reform and development, and participate in the formulation of legislation, planning, industrial policies, guidelines, industry entry conditions, and reform for the energy sector.

Social Actors

Academics also play a key role in the policy network. Under President Hu Jintao's model of "Scientific Outlook on Development," government agencies are required by party rules and laws to perform evidence-based policymaking by engaging in policy deliberation and consultation with industry experts and scholars. Academics are therefore considered strong supports for building the capacity of policymakers and other stakeholders. Especially in the realm of climate and energy policy, academics are often at the forefront of cutting-edge research and provide crucial insights into policy issues based on their specialized knowledge. By participating in networking activities, they can disseminate scientific findings and inform policy debates, ensuring that decisions are based on the latest evidence and research. Networks allow academics to connect with policymakers, the industry, and other stakeholders, fostering collaboration and partnerships, and building coalitions for specific policy goals. They often bridge the gap between policymakers and the industry, as well as international actors by highlighting the independence of academic research.

Other significant policy actors are NGOs. In the Chinese authoritarian regime, the role of NGOs and think tanks in the policy community can be more nuanced and challenging due to the constrained political environment. Energy and climate policy is one of the few areas in which they can participate and exert significant influence. In particular, NGOs and think tanks often rely more on informal networks and connections to build coalitions and mobilize support from the industrial complex. By cultivating relationships with sympathetic government officials, business leaders, and academics, these organizations can influence policy discussions and decision-making processes from within the system. Similar to academics, NGOs and think tanks can contribute valuable expertise, research, and policy recommendations that can help

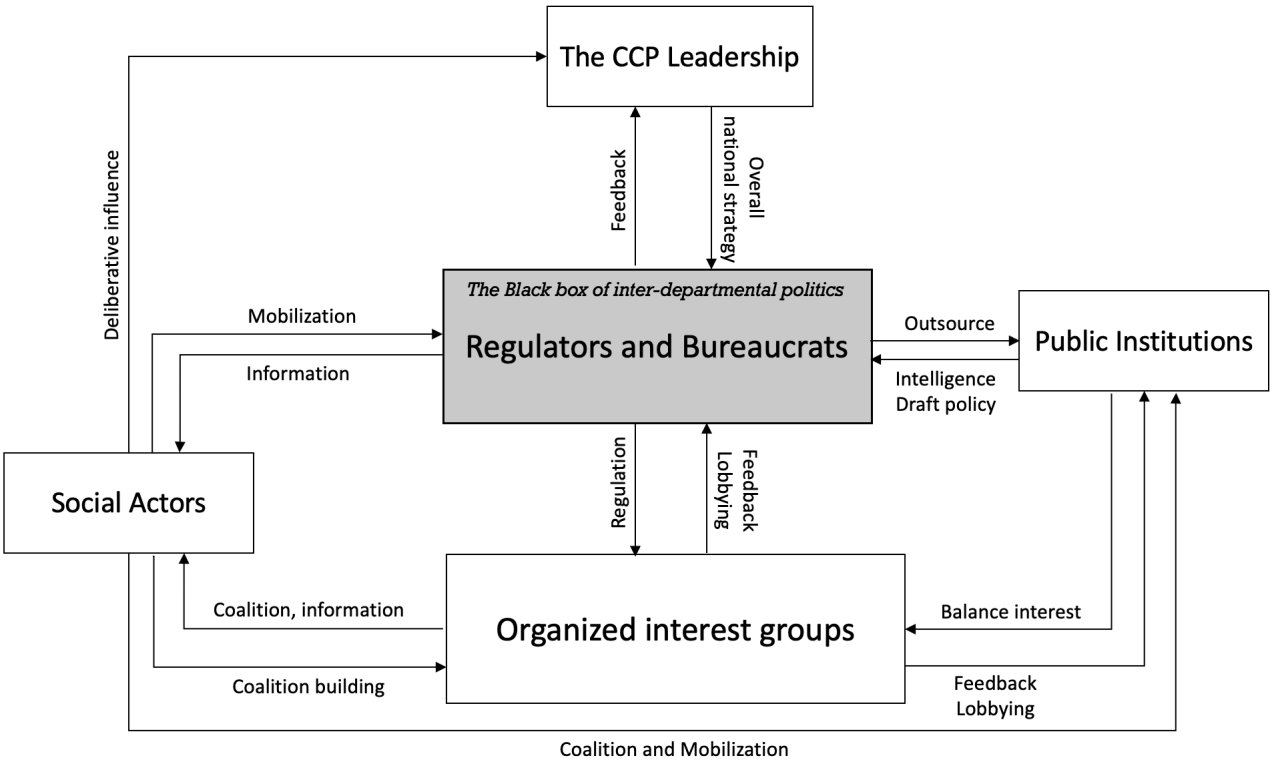

Figure 2: Networking Structure and Interactions between Domestic Policy Actors (Source: Author)

inform government decision-making by presenting evidence-based policy alternatives. They focus on behind-the-scenes lobbying and persuasion rather than public campaigns or protests. Surprisingly, many influential NGOs in the Chinese policy community are US-based, such as the Natural Resource Defence Council, Brookings Institution, the Energy Foundation, and World Resource Institute. By adopting context-appropriate strategies and approaches, these foreign NGOs can influence policy discussions, build support for their proposals, and contribute to more effective and inclusive decision-making processes. Figure 2 summarizes the networking structure and interactions among different policy actors in China.

International Actors

In addition to domestic actors, international policy actors can also play a significant role in Chinese energy and climate policy. In view of the global nature of climate issues, a group of policy entrepreneurs across the globe has been actively engaging with government regulators in different countries, seeking to shape policy outcomes. In the Chinese context, the energy and climate policy arena stands out as one of the few domains that invite and embrace signif-

icant international participation and cooperation. This openness to international collaboration traces its roots back to the era of Deng Xiaoping. His pivotal visit to the United States in 1979 marked a crucial turning point in the trajectory of China's relations with the West. It was then that energy cooperation was identified as one of the primary areas for bilateral and multilateral engagement, laying the groundwork for what has become a dynamic and complex web of international interactions within China's energy and climate policy landscape. International actors, also including foreign investors and those from intergovernmental organizations, play a crucial role in shaping China's energy and climate policy, bringing to the table global perspectives, novel ideas, and innovative solutions that enrich the discourse and contribute to the collective pursuit of energy transitions. Their participation underscores the inherently global nature of climate change and the importance of cross-border cooperation in tackling its challenges.

Data

Identifying the Policy Community in Beijing

To identify the structure of policy networks and individual policy actors at the central government, I collect original data on the policy communities in Beijing using an event-based approach. I collect data on panelists at climate and energy-related conferences, co-authors of policy reports, as well as committee members on government task forces. The data is sourced from the websites of NGOs, SOEs, business associations, public institutions, and universities, available in formats such as conference records and news releases. Therefore, nodes in the network contain the following three kinds of individuals:

- Individuals featured in policy-oriented public events/conferences hosted by different organizations, such as policy meetings organized by China's Energy Bureau, climate-related conferences, and public events sponsored by public institutes, NGOs, or business associations in Beijing;
- Individuals from government agencies, research institutions and NGOs who co-authored

published products, including policy briefs, industrial reports, or other forms of policy documents;

- Individuals who participated in energy or climate-related government task forces or committees in the government.

Ties are defined as either co-authorship of policy products or co-attendance of conferences. In other words, participants are included in the study population if and only if they co-attend at least one conference or co-author at least one policy product with another. The relationship (edge) between two individuals is defined as the number of conferences attended or policy documents issued with each other in a particular time frame. I then code notes' attributes by type based on their affiliations (eg. government officials, academics, NGO, SOE, etc.) and sectors based on expertise (eg. renewable, coal, climate, etc.). The data covers the years 2014 through 2019. A network is constructed each year, with the network size varying from around 1,000 to 1,300 nodes per year and 6,990 over six years. This approach allows me to identify 3,118 policy actors (unique nodes) in total.

The event-based approach reflects the network generation process. This methodology captures the dynamism and nuances of interpersonal interactions that often shape the policymaking process. It is through these in-person engagements - such as conferences, seminars, or group meetings - that policy actors can effectively establish and strengthen connections, share pertinent information, and organize lobbying activities to advocate for their policy interests. These events represent the breeding grounds for cross-pollination of ideas, fostering dialogue, and facilitating consensus-building among diverse stakeholders. The relationships formed at these gatherings often persist beyond the event itself, giving rise to robust networks that can powerfully influence policy decisions.

This approach has two advantages compared to other measures of networks. First, it avoids false positive accounts of interactions. If policy actors' interactions are publicly observed, they will likely share the tie behind the scenes. Second, even though some measurement errors might not be fully accountable, this measure of network structure should be highly correlated

with the true connections between policymakers and policy actors.

Analysis

In this section, I conduct some basic network analysis and identify the most important policy actors by assessing their position in the network. Table 1 shows a distribution of actor types by expertise, representing different climate topics and energy sectors.

Government Actors

Actors from the government and government-affiliated public institutions have the highest share, which together accounts for 25 percent of the total nodes. In particular, among 1,455 notes representing government officials active within the network, a significant proportion is divided among four key agencies: the NDRC with 366 entries, the NEA with 244, the State Council contributing 189, and the MEE/MEP with 176. Together, these integral agencies account for nearly 68 percent of the government actors.

This distribution of affiliations among government actors mirrors the power dynamics in the energy and climate policy arena. Consistent with my theory, the NDRC, as the predominant ministry, exerts significant control over project approvals and energy pricing, making it the most active governmental actor. The NEA, serving as the direct regulator responsible for policy design, is also actively engaged, ranking second in activity. The State Council, as the highest regulatory body, plays a crucial role in grand strategy decision-making. Lastly, the MEE/MEP, while not as powerful, is significantly involved in environmental (and subsequently, climate) regulations, despite being a relatively less influential ministry compared to the other three. All the other 18 ministries on the National Energy Commission represent only 32 percent nodes, indicating weak voice and leverage in energy and climate governance.

Social Actors

Academic actors from universities constitute the most substantial community within this

network, particularly concentrating their expertise on matters pertaining to climate change and the environment. Tsinghua University stands out, representing the largest group within this community with 351 nodes, a figure that is more than double the size of the second-largest group, the Chinese Academy of Science, which contributes 170 nodes. In comparison, Peking University, another prestigious institution in China, contributes a modest 67 nodes to the network. This distribution underscores the power dynamics within climate and energy affairs, with Tsinghua University emerging as a preeminent institution. I dive deeper into the influence exerted by Tsinghua University later. Among the academic actors, a notable presence of 162 nodes is from international universities, demonstrating the global attention and collaborative efforts towards energy and climate issues. From this international cohort, Harvard University stands out with 23 nodes, indicating its considerable role within the global academic community.

NGOs constitute another significant group of social actors within this network. Their focus predominantly lies in the realms of climate change, environment, and renewable energy. What is striking, however, is the substantial presence of international affiliations within this group. Out of the 516 NGO nodes in the network, a considerable majority – 450 nodes – are associated with international NGOs. This highlights the transnational nature of these critical issues and underscores the global commitment to addressing them. Especially, actors from American NGOs emerge as the most prominent group within this international cohort. Numerous esteemed American NGOs, such as the World Resource Institute, Natural Resource Defense Council, the Brookings Institution, Paulson Institute, and the Energy Foundation, actively participate and influence the policy dialogue. These organizations are not just spectators in the policy arena, but key players who are shaping the discourse and driving the action. Their active involvement underlines the depth and breadth of engagement between the United States and China on climate issues. Their participation indicates that the dialogue and cooperation on climate change between the United States and China extend beyond governmental corridors. It permeates society, fostering a robust engagement at multiple levels – diplomatic, academic, and social. This all-encompassing involvement underscores collective commitment and collaborative efforts to address the complex and global challenges posed by climate change.

Table 1: Summary of Policy Actors (2014-2019)

	Type											
Sector	Academic	BA	FGOV	FOE	GOV	IGO	Media	NGO	PI	Private	SOE	Total
Climate	307	36	42	5	219	42	0	200	20	8	2	881
Other	159	12	77	37	243	23	6	53	32	59	8	709
Environment	210	12	42	8	188	44	0	93	56	20	6	679
Renewable	61	102	8	41	68	14	1	15	9	264	86	669
General energy	111	81	25	15	293	27	1	47	4	34	14	652
Electricity	140	173	7	25	40	3	0	9	12	50	158	617
Oil & Gas	76	32	1	54	47	11	0	7	14	63	225	530
Coal	96	126	2	1	43	4	0	1	10	19	67	369
Finance	36	10	6	20	62	38	0	27	15	23	59	296
Grid	45	11	1	0	2	3	0	4	4	9	166	245
Transportation	30	18	2	16	32	1	3	21	9	45	54	231
Industry	57	34	1	21	43	3	0	2	9	23	24	217
Energy conservation	36	31	2	3	46	9	0	21	7	20	14	189
Technology	46	17	1	8	49	1	0	2	7	29	8	168
Hydro	28	16	0	1	22	1	0	3	37	2	49	159
Urban planning	38	2	7	2	38	1	0	27	21	3	4	143
Nuclear	44	14	0	2	20	0	0	1	3	1	33	118
Storage	30	20	0	2	0	2	0	0	0	48	16	118
Total	1,550	747	224	261	1,455	227	11	533	269	720	993	6,990

Source: Author

Once again, this distribution of social actors within the network not only provides a reflection of the contributions made by different institutions but also reveals the power dynamics within the arena of climate and energy affairs. It emphasizes the leading role of certain institutions, like Tsinghua University and the Energy Foundation, and illustrates the international collaboration that characterizes this field.

Interest Groups

Domestic interest groups comprise state-owned enterprises (SOEs), private entities, and business associations. From 2014-2019, SOEs have emerged as the most prolific, amassing a total of 993 nodes. Within this group, a significant 23 percent represent the oil and gas industry, while a modest 9 percent signify the renewable industry, and a further 7 percent hail from the coal industry. In the electricity sector, state-owned electricity companies account for 16 percent of the experts, while an impressive 17 percent are from the grid sector. As the grid system is predominantly controlled by two state-owned entities, mainly the State Grid, a stark power imbalance is evident between electricity generators and the grid operator.

In contrast, the distribution of the private sector and the business associations paint a different picture. Renewable developers constitute a commanding 37 percent of private actors, while 9 percent are affiliated with the oil and gas sector, and a mere 3 percent are associated with the coal industry. The distribution of sectorial interest within business associations diverges yet again. A significant 17 percent of actors from business associations represent the coal industry, while 14 percent are associated with renewables, and only 4 percent are tied to the oil and gas sector.

This dynamic landscape might reflect the underlying strategic preferences of various industries. The coal industry, for instance, appears more inclined to influence policy through semi-governmental business associations. The privately owned renewable industry, often lacking institutionalized channels, seems to favor direct networking with government officials. The monopolies, i.e. the State Grid for the grid sector and three ‘Big Oils’ for the oil and gas sector, likely wield significant influence through their direct access to decision-makers. This represen-

tation of interests unveils the varied influence distribution within China's energy sector.

International Actors

Foreign government officials, international organizations, and the foreign business community constitute the international actors. Collectively, these actors account for more than 700 nodes, representing over 10 percent of the overall network. A striking feature of this global cohort is the significant representation of government actors from Europe and the United States, who together constitute nearly 70 percent of the total foreign government officials. Among these actors, European officials are notably prominent, accounting for 43 percent of the total. The most active players come from the embassies of Germany, the UK, Norway, Denmark, the Netherlands, and the European Union, each playing an instrumental role in the policy network. In contrast, government officials in the US embassy have been absent from this network. The American governmental engagement in the network predominantly involves high-ranking officials or cabinet members from the federal government, who are more likely to interact directly with their high-ranking counterparts in the Chinese government. This pattern suggests an intriguing dynamic at play – the Chinese government seems to exhibit a preference for direct engagement with the hegemon, the United States, underscoring the country's perceived priority status in China's foreign policy and international relations in the context of energy and climate policy.

The Network Structure

On the network level, as shown in Figure 3, government officials are embedded in a diverse network, both in terms of type and sector. The width of edges that connect government actors and others are listed in table 2. In the network graph, the size of the nodes is proportional to the frequency of individuals from each type or sector, and the thickness of the lines is proportional to the frequency of edges. This proportional representation provides a clear, intuitive understanding of the network structure, highlighting the most active and interconnected actors within the network.

The network on the left depicts the intricate connections among various types of actors.

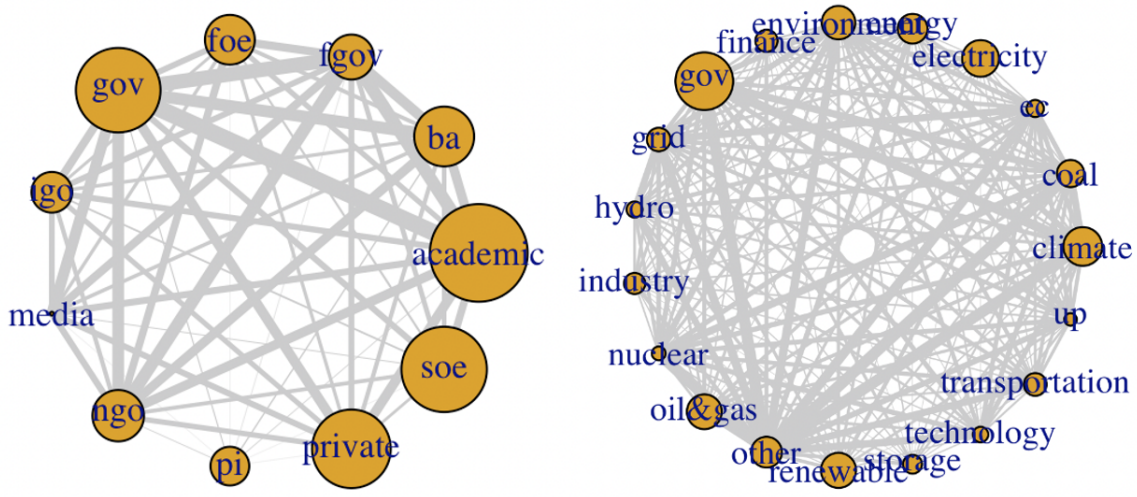

Figure 3: Network Structure by Types (left) and by Sector (right)
Source: Author

Table 2: Government Actors' Connections with Different Actors by Types and Sectors

Type	Frequency	Sector	Frequency
academic	5760	oil&gas	2944
soe	4320	environment	2836
ba	2924	other	2796
private	2786	climate	2732
fgov	2478	renewable	1914
ngo	2036	electricity	1638
igo	1368	energy	1552
pi	792	finance	1208
foe	740	coal	1068
media	30	grid	962
		ec	726
		transportation	638
		hydro	340
		technology	340
		up	320
		storage	282
		nuclear	190

Source: Author

Government officials notably demonstrate stronger connections with private sector entities and foreign enterprises. Academics and business associations also exhibit significant linkages with government officials, reflecting a vibrant exchange of ideas and initiatives. Contrary to expectations, SOEs display limited connections with government actors. SOEs, traditionally believed to possess more direct and institutionalized channels for policy engagement, seem to have fewer interactions within this network. This counterintuitive observation suggests that private and foreign investors, who lack such institutionalized channels, may have stronger incentives to actively engage in networking activities with the Chinese government. By fostering these connections, they can gain more influence and access to the policymaking process. This dynamic underscores the importance of understanding the network relationships between various actors, as it can shed light on the nuanced power dynamics and strategies at play in the policy landscape.

The network on the right shows the connections between government officials and actors from various sectors. From the government's perspective, interestingly, no single sector emerges as the dominant interest in these linkages, indicating a well-distributed and diverse set of connections. This diverse network reveals that government officials are indeed surrounded by a rich array of perspectives and interests, providing them with a comprehensive and multifaceted understanding of the policy landscape. This diversity of connections is of significant importance in the context of decarbonization efforts. It allows central government officials to access a wide range of ideas, expertise, and perspectives, thus fostering a more informed and nuanced approach to policymaking. By engaging with this diverse set of sectorial interests, government officials are better equipped to devise comprehensive and effective policies that address the complexities of decarbonization.

The Most Influential Actors

The network perspective further allows me to discern and categorize key actors within the climate policy community. For this purpose, I apply the theory of structural holes as a mechanism

for identifying these pivotal actors. As outlined by Burt (1995), individuals who are strategically positioned in a structural hole between distinct groups have greater social capital. This results from their capacity to gather and disseminate ideas and influence from various groups, acting as bridges or connectors in the network. These 'brokers' who occupy the structural holes have unique opportunities to foster communication and catalyze the flow of information among nodes that would otherwise be disconnected or loosely linked (Burt, 2004). By possessing access to diverse groups, they are in a position to synthesize and communicate a broad spectrum of ideas, issues, and perspectives across the network (Lubell, 2007). Moreover, these actors occupy a central role in mitigating policy deadlock and minimizing efficiency loss, which often emerge from conflicts of interest and misunderstandings surrounding policy implications and opportunities. Their strategic positioning and bridging function enable them to foster shared understanding, coordinate efforts, and potentially reconcile divergent interests (Lubell and Fulton, 2008), thereby enhancing policy efficiency and effectiveness. Consequently, their role in identifying and exploiting structural holes within the policy network is pivotal in shaping the trajectory and outcome of climate and energy policy.

In this chapter, I identify structural holes by using centrality measurements that dissect the properties of nodes. Betweenness centrality [2], specifically, is an important measure that captures the potential influence of an actor over the spread of information through the network. It quantifies the number of times an actor functions as a bridge along the shortest path between two other actors. In other words, an actor with high betweenness centrality has a significant influence on the network, often controlling the flow of resources or information, and connecting disparate groups. Table 2 lists the top 20 most critical actors within the network, ranked by betweenness centrality. Degree centrality [3] is also listed to support the betweenness measurement. These actors, due to their high betweenness centrality scores, are pivotal to the network's structure and function, often acting as the connecting nodes within the network. They are instrumental in disseminating information, facilitating collaboration, and maintaining the coherence of the network. I also include degree centrality, measured as egos' number of

[2] Betweenness centrality of a node n is the sum of the fraction of all pairs shortest paths that pass through n.

[3] In an undirected network, degree centrality is simply the number of links incident upon a node (i.e., the number of ties that a node has).

connections, and frequency of appearance for robustness check. In theory, a node that occupies the structural hole tends to be well connected and frequently serves as the bridge of multiple groups, and therefore tends to also have a higher degree centrality and higher presence in the network.

As anticipated, government officials from the NDRC and the NEA figure prominently among the actors with the highest betweenness centrality. Over half of these top actors are officials, or have previously held positions, within the NDRC and the NEA. This demonstrates the pivotal role these entities play in the information flow and structural cohesion of the network. Among these influential actors, I find a notable figure, Xie Zhenhua, recognized as China's climate Czar under Xi Jinping. As a top-ranking actor within this network, his high betweenness centrality reflects his crucial role in bridging gaps within the network, facilitating communication and collaboration across various actors and sectors. Identifying Xie Zhenhua as a key player provides a compelling validation of the utility of the network analysis approach. By applying the concept of betweenness centrality, I am able to pinpoint not just the most active actors, but the most influential ones.

Academic figures also prominently feature among the most influential actors in this network, underscoring the significant role they play in shaping climate policy. Distinguished scholars such as Du Xiangwan from the Chinese Academy of Engineering, Wang Yi from the Chinese Academy of Sciences, and He Jiankun of Tsinghua University stand out as the most influential academic actors in the sphere of climate policy. Their high betweenness centrality signals that they are pivotal figures who actively orchestrate coordination and collaboration within the network. By occupying the 'structural holes,' these academics are uniquely positioned to mobilize resources and build coalitions, thereby significantly enhancing the flow of ideas and consensus within the policy network. As key influencers in the network, they can direct discourse, facilitate connections, share knowledge, and mobilize resources for deliberative engagement with the government, thereby significantly contributing to the promotion and progression of climate policy.

Table 3: Top 20 Well-Connected Actors in China (2014-2019)

Name	Affiliation	Sector	Type	Betweenness	Degree Centality	Frequency
Li Junfeng	NDRC	climate	gov	424,468	818	53
Zhou Dadi	NDRC	climate	gov	291,029	738	41
Han Wenke	NDRC	energy	gov	237,706	630	26
Shi Yubo	E.R. Society (Former NEA)	energy	ba	206,644	514	34
Zhang Yuqing	NEA	energy	gov	198,344	514	20
Du Xiangwan	Chinese Academy of Engineering	climate	academic	188,510	446	32
Wang Yi	Chinese Academy of Sciences	climate	academic	165,242	464	25
Xie Zhenhua	NDRC	climate	gov	164,030	424	39
Shi Dingyuan	China Renewable Energy Society	renewable	ba	149,068	384	21
Yang Kun	NEA	electricity	gov	133,766	322	24
He Jiankun	Tsinghua University	climate	academic	122,973	450	40
Dai Yande	NDRC	energy	gov	122,851	538	17
Wang Peng	North China Electric Power University	electricity	academic	121,410	302	9
Wang Zhongying	NDRC	renewable	gov	113,719	470	17
Zou Ji	Energy Foundation (U.S.)	climate	ngo	113,551	388	19
Ouyang Minggao	Tsinghua University	transportation	academic	100,692	224	7
Wu Yin	NEA	energy	gov	93,824	334	13
Zhou Xiaoxin	Chinese Academy of Sciences	grid	academic	87,237	324	19
Wang Zhixuan	China Electricity Council	electricity	ba	87,200	180	16
Zhou Fengqi	NEA	renewable	gov	81,008	180	15

Source: Author

Zou Ji emerges as the most influential actor among NGOs. He is the President of the Energy Foundation China – a US-based NGO dedicated to promoting energy transition and combating climate change in China – his influence extends far beyond this role. Before assuming his current position, he served as the Deputy Director of the National Center for Climate Change Strategy and International Cooperation (NCSC), operating under the aegis of the NDRC until 2018, and subsequently under the MEE. Interestingly, his transition from a governmental position to leading a US-based NGO has not diminished his structural influence within the Chinese policy network. On the contrary, he maintains a critical role and continues to exert significant influence. His unique career trajectory, straddling both government and NGO sectors, coupled with his extensive experience and wide-ranging connections, have equipped him to effectively navigate the network and build strategic alliances. By occupying a structural hole in the network, Zou Ji is able to facilitate communication, foster understanding, and promote cooperation among diverse actors, thereby driving the progress on energy transition and climate change in China.

The decision-making process concering carbon neutrality policy reflects the dynamics between social and governmental actors. According to my interview, a group of NGO leaders and academics act closely with government officials to promote this ambitious goal. "I communicated the idea of carbon neutrality with the NEA officials back in 2016, but they thought it was too rushed and too ambitious," said Zou Ji (ranked number 15 on this list), "I then thought of starting with solid research, so we changed the strategy to funding research with our friends and partners at Tsinghua University." In 2017, Xie Zhenhua, the former minister of environment and Chinese special envoy on climate change, founded the Institute of Climate Change and Sustainable Development (ICCSD) at Tsinghua University. He invited a group of influential scholars in the field, such as He Jiankun and Zhang Xiliang (ranked 11 and 30 in terms of betweenness centrality, respectively), to join the ICCSD and conduct research on energy transition and decarbonization. In 2018, the Energy Foundation and ICCSD jointly funded a research project on the long-term low-carbon development and transition path in China, which studied the timetable and feasibility of decarbonization. They brought together a group of well-connected climate scientists from Tsinghua University and the Chinese Academy of So-

cial Science, as well as senior government officials from the NEA, NDRC, MEE, the Ministry of Transportation, and the Ministry of Commerce. Consequently, this research made a substantial impact on China's climate policy. "Eventually, Minister Xie (Zhenhua) took the findings of our research to the top leaders and convinced Xi Jinping to make the carbon neutrality commitment," as Zou Ji puts it: "This (the Carbon Neutrality policy) is impossible without these group efforts and research evidence."

Conclusion

This chapter discusses the energy and climate policy network in Beijing. Studying policy networks is important for understanding the opaque policymaking process for several reasons. First, examining the relationships and connections among policy actors within policy networks helps to uncover the underlying structure and dynamics of the policymaking process. By mapping these relationships, analysts can identify key influencers, gatekeepers, and brokers who play significant roles in shaping policy outcomes. Understanding the network structure can also reveal potential alliances and coalitions that form around shared interests and goals, as well as opposing factions that may resist or challenge specific policy initiatives.

Second, policy networks can reveal areas of convergence and divergence among actors, providing insights into the struggles and compromises that occur during the policymaking process. As various stakeholders participate in the policy process, they bring their own interests, objectives, and perspectives to the table. Understanding these dynamics is crucial for recognizing the challenges faced by policymakers in balancing competing interests and priorities. By identifying shared interests among actors, analysts can uncover potential areas of collaboration and predict which policy proposals are likely to gain support within the network. Conversely, policy networks can also expose areas of disagreement and tension among actors. These conflicts may stem from differing ideologies, policy preferences, or resource competition. Understanding the sources of these conflicts can help policymakers anticipate potential roadblocks and opposition to policy proposals, enabling them to devise strategies to mitigate or address these disagree-

ments. The exposure of central governments to such diverse policy networks is consequential. Various actors and sectors can influence policy directions and decisions by utilizing the interconnectedness and interdependencies that characterize modern policymaking. As such, the network analysis approach provides valuable insights into the drivers of decarbonization, and can inform strategic efforts to accelerate progress in this critical area.

Third, the network analysis approach helps to identify the most influential policy actors, i.e., the structural holes, in the network. By examining the structural position held by individual actors, I was able to quantify the influence of individuals and the power dynamics among them. While the prominence of figures like Xie Zhenhua, Zou Ji, and He Jiankun effectively supports the potency of the network approach, the contrasting case of Ding Zhongli offers a fascinating counter narrative that reinforces the validity of the network approach. A recognized climate expert affiliated with the Chinese Academy of Sciences, Ding also held the position of vice chairman of the Standing Committee of the National People's Congress. This high-ranking role positioned him as the most senior official who has expertise in climate change within the Chinese government and to represent China at the COP15 in Copenhagen. However, in reality, Ding's position is far less influential than it seems. In fact, his betweenness centrality ranks 2,958 out of 3,118 actors in the network. In other words, despite his high ranking in the government, he does not occupy any structurally important position in the network. This rank reflects Ding's contentious reputation within the community, rooted in his skeptical stance on climate change. His assertion that China should not make any climate commitments, given his belief that climate change is primarily caused by developed countries, has been met with widespread disapproval. Therefore, despite Ding's high-ranking position within the government and his popularity among many nationalist Chinese netizens, his controversial views on climate change have led to his marginalization from climate-related policymaking since 2008. His divisive reputation persists today, with many Chinese climate experts expressing continued resentment. One expert comments, "Ding Zhongli single-handedly held back the climate research branch in the Chinese Academy of Sciences and destroyed their policy influence for an entire decade." This example illustrates the complex interplay of power, influence, and ideological alignment in climate and energy governance. It serves as a potent reminder that an

individual's official rank or title does not necessarily equate to influence within a policy network, particularly when their views diverge from the prevailing consensus.

China, like many other countries, has a complex economy and society where actors have diverse policy preferences. The central government's exposure to the diverse network is critical for promoting decarbonization and encouraging climate action. In the next chapter, I provide quantitative evidence to support the theory by studying the provincial network. Using the same data generation process, I identify the provincial policy network. The temporal and spatial variations allow me to conduct statistical analysis. I leverage a quasi-natural experiment to estimate the causal effect of network diversity.

Chapter 5

The Power of Networks:

Renewable Development at the Local Level in China

Introduction

Policymakers across different administrative levels are embedded in complex social relations that connect them to groups with sometimes diverse policy preferences. Through these connections, political, economic, and social actors can exert their influence on different stages of the policy making process. Within a specific institutional context, it is often the formal and informal processes of negotiation, cooperation, and compromise among these actors that determines policy outcomes. Especially in contexts where transparency and institutionalized accountability are weak, informal processes of preference aggregation often play a decisive role in policy outcomes. Therefore, it is essential to investigate how societal and political actors engaged in policy processes, and how actors' objectives shape government policy.

This actor-centered perspective, however, is largely overlooked in the relevant literature. On the one hand, the existing research on policy processes mainly emphasizes formal and informal institutional contexts and associates deeper connections between policymakers and local policy stakeholders with less inter-locality coordination, inefficient national policy delivery and public good provisions (Jensen and Mortensen, 2014; Lieberthal and Oksenberg, 1988; Steinberg and Shih, 2012; Tan, 2020). On

the other hand, literature on bureaucratic organization highlights the positive effect of bureaucratic embeddedness on public goods provision rather than the actors (Bhavnani and Lee, 2018; Evans, 1995; Kohli et al., 2004). The composition, objectives, and interactions of relevant actors in policymakers' embedded networks are treated as specific to local conditions and are often bypassed in these studies.

In this chapter, I develop an analytical framework for assessing the influence of state-social relations on policymaking processes. I argue that the diversity of relevant policy networks in which decision-makers are embedded facilitates government capacity that allows, rather than forestalls, effective policy delivery. Government agents embedded in policy networks of various economic and social actors benefit from heterogeneous state-social linkages, which determine state agencies' knowledge about, and preference for, alternative policies. The structure of this policy network provides policy entrepreneurs with a platform through which individuals connect and attempt to influence decision-makers. Therefore, diverse policy networks strengthen government autonomy and thereby increase state capacity in policy delivery.

I test this argument in the context of renewable energy development in China. The case of China is especially intriguing because even though informal elements are expected to play an important role in decision-making, research falls short of empirical cases. This is in part because of the opaque nature of policymaking and the precarious composition of organized interests in the authoritarian state. Furthermore, energy policy is an area especially vulnerable to local interest group capture because of the substantial taxes and economic rents generated by the energy industry. Even though the Chinese central government has strong economic, environmental, and political incentives to promote renewable energy, its renewable energy agenda often faces compliance issues and is sabotaged by local government agencies that have strong interests in promoting local mining and fossil fuel consumption. This chapter argues that policymakers' informal networks are an essential factor for understanding why the level of renewable energy development is greater in some localities than in others.

To assess the role of policy networks, I collect original event-based network data on policy communities of over 13,000 individuals in the energy policy arena across 26 provinces from

2014 to 2019. The individual-level data contains information on actors' affiliations. I code every non-government actor by industrial sectors and calculate the sectorial diversity of policymakers' networks using the Herfindahl–Hirschman index. I use a variety of control variables and fixed effects to estimate the effect of network structure on renewable development. To minimize endogeneity bias, I leverage the annual average wind speed as an instrument for network diversity, because poor renewable electricity utilization caused by a natural shock would encourage networking activities of relevant actors, which in turn would diversify the policy network dominated by traditional energy sources. My results show that, on average, network diversity increases renewable development. Furthermore, I explore the causal mechanisms using quantitative and qualitative approaches. In the context of energy governance, I believe both interest configuration and deliberative influence co-exist in the policy process and jointly determine the policy choices of decision-makers.

This chapter also contributes to the understanding of authoritarian governance. Although a general expectation of authoritarian policymaking attributes policy outcomes to elite compromise and political cooptation (Acemoglu and Robinson, 2006; Boix et al., 2013; Chen et al., 2016; De Mesquita et al., 2005; Lieberthal and Oksenberg, 1988; Meng et al., 2017; Mertha, 2009; Steinberg and Shih, 2012; Svolik, 2009), more recent literature implies that decision-makers in many authoritarian states are also embedded in pluralist social structures that consist of various stakeholders and social actors (Anderson et al., 2019; Bindman et al., 2019; Clark, 1995; Gallagher and Xuan, 2019; Heurlin, 2010; Liu et al., 2017; Lorentzen et al., 2013; Spires, 2011). For example, many non-governmental expert advisors are involved in formal decision-making processes by directly submitting suggestions to, or sitting on, the advisory boards of government agencies (Gallagher and Xuan, 2019). Other economic and social actors, including SOEs (Wang, 2018), private business (Hou, 2019; Wang, 2016), NGOs, and thinktanks (Anderson et al., 2019; Duckett, 2019; Mertha, 2009; Teets, 2018) also exert influence in the policy process. This newer literature suggests that, just as in other complex and advanced economies, we should expect China's policies to reflect diversified socio-economic and political interests. Theoretically, this conceptualization of authoritarian governance reconciles insights from research emphasizing informal institutions and embedded autonomy aspects

of policymaking, providing a micro-level social foundation for a state-led governance system. Practically, studying the dynamics of the policy community surrounding policymakers is critical for understanding policy paths and outcomes. This study is the first to fill the gap in the literature by systematically identifying the structure of, and important actors in, the energy policy communities in China.

Finally, this research contributes to a growing literature on diversity and public goods provision. Contradicting traditional views about social, ethnic, and religious fractionalization, recent literature demonstrates that higher levels of social diversity promote state capacity and public goods provision (Charnysh, 2019; Cruz et al., 2020; Lublin, 2017; Wang, 2022). I add to these efforts by establishing the causal effect of policy network diversity and by demonstrating the importance of the composition of state-social relations for government policy delivery.

Policy Networks in an Authoritarian Regime

Most existing scholarship on policy processes focuses on formal institutions and how fractionalization of the institutional structure undermines efficiency and inter-departmental coordination (Jensen and Mortensen, 2014; Powell and Whitten, 1993; Tsebelis, 2011). These theories are particularly relevant in the context of state-led modernization in which governments are responsible for encouraging and coordinating development through economic and industrial planning (Haggard, 2018). In the case of China, fractionalization is a common cause of governmental inefficiency and lack of coordination (Lieberthal and Oksenberg, 1988; Montinola et al., 1995; Qian and Weingast, 1997), and the repeating cycle of decentralization and re-centralization of power (Birney, 2014; Kostka and Nahm, 2017; Oi, 1992), inhibiting the Chinese central government's capacity for delivering its national goal and international commitments (Tan, 2020; Zhou, 2017). These arguments, however, have limited explanatory power for analyzing policy changes, because the institutional structure often does not vary across subnational units and would likely experience little change overtime without substantial political reform.

I argue that in authoritarian regimes with a weak accountability system, where bureaucrats are responsible for policy development, pluralistic policy networks enhance the government's capability to promote policy goals. This argument builds on two assumptions: that a policy actor in the network represents the interest of a specific sector, which is associated with their professional affiliation, and that their objective is to affect government policies to advance the interests of their own sector. Network compositions could influence government decision-making through two potential mechanisms. First, a diverse network could provide more complete information and more policy ideas in a specific governance arena. In a state-led development system, government agents often need to overcome information asymmetry. From a practical perspective, they rely on experts and professionals for assistance and information, opening opportunities for different interests or perspectives to influence government actions. The structure of the policy network provides policy entrepreneurs with a platform through which individuals connect and attempt to influence decision-makers in a subtle and indirect way. A more diverse perspective is likely to discover solutions to difficult problems and challenges (Hong and Page, 2001).

Second, a diverse network could provide multiple sources of political support for local policymakers, preventing local capture. Concentrated policy networks constitute what Olson calls narrow interest groups (Olson, 1982). If a bureaucrat is embedded in a policy-relevant network that consists of narrow interest groups where actors share relatively homogeneous policy preferences, then he or she is likely to be captured by a specific interest, which often seeks favorable treatment at the expense of their competitors or the general public. When the policy preference of the established interests is inconsistent with the national goal, local agents might be pressured to choose the policy that satisfies the dominant interests in their network for staying in power, causing a significant compliance problem because of the divergence of interests between principals and agents, which arise in hierarchical bureaucratic systems (Evans and Rauch, 1999; Malesky et al., 2014). Additional representation of diverse stakeholders could counterbalance the influence of the established interests. If multiple sources of support exist in a policy arena, local bureaucrats can choose among them and thus have more flexibility in complying with the central policy. In other words, a pluralistic composition of an informal

socio-economic institution could reduce agency loss associated with the formal institution.

These mechanisms manifest in policy processes in the electricity sector for two reasons. First, policy actors from the energy industry have incentives and structural opportunities to influence policy. The electricity market is highly regulated. Local governments, however, often lack the necessary capacity to govern the industry effectively. Compared to other industrial sectors, the modern electricity system with high renewable penetration is a complex system that poses severe challenges to governance because of its high level of connectivity, nonlinear patterns of change, dynamic and directional processes, and emergent properties and frequency of surprises (Young, 2017). For regulators, electricity planning and operation have relatively high technological thresholds, which could prevent arbitrary decision-making. Provincial governments have neither the expertise nor the capacity to regulate the sector effectively. Thus, government officials have grown increasingly dependent on scholars, experts, and industrial professionals with their interests and policy agendas associated with their backgrounds and organizational affiliations. For instance, even though the local Energy Bureau is the formal regulator of the electricity industry, it relies heavily on experts' assistance from the electricity industry in drafting electricity plans, opening up opportunities for grid companies and electricity generators to influence government actions. Other social actors, such as NGOs, think tanks, and scholars from research institutions, also assert influence over governments by providing expertise and information on policy implementation (Anderson et al., 2019). I further discuss the role of different players in the Chinese context in the next section.

Second, the energy industry is represented by multiple interest groups that compete for preferential treatment for construction permits and market share by capturing the regulators. Traditionally, the fossil fuel industry is well-organized, making it easier for it to engage in rent-seeking activities because its interests are aligned and concentrated enough to bear the transaction costs in organizing to demand rents (Olson, 1965). Fossil fuel interest groups, with their strong capability to utilize formal and informal institutions to pursue their political agenda, often take advantage of political cycles and successfully lobby for their own business interest at the expense of the interests of society as a whole and of future generation (Acemoglu and

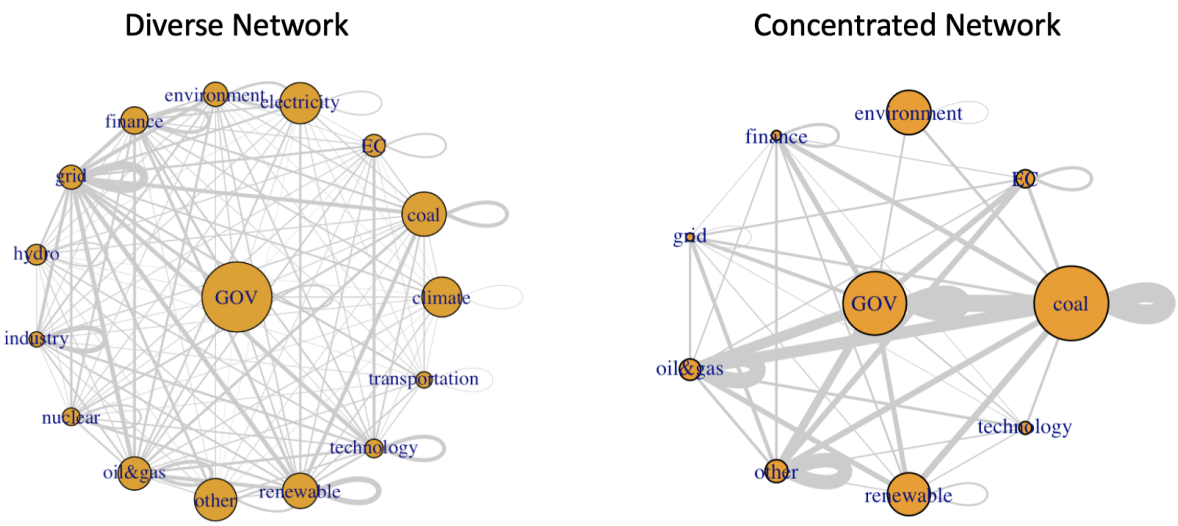

Figure 1: Diverse Network vs. Concentrated Network (Source: Author)

Robinson, 2006; Dasgupta, 2018; Egli et al., 2022; Shen, 2022). Because politicians in both democratic and authoritarian regimes tend to prioritize short-term political and economic gain for staying in power (De Mesquita et al., 2005), the pressure of increased demand from economic growth and fossil fuel dependency could make governments reluctant to transition away from cheaper fossil fuels. In the era of clean energy transition, however, as technology development and economies of scale bring down costs, alternative energy sources can challenge the incumbent fossil fuels by translating their resources and increasing market share into lobbying capacity. Consequently, as the policy network diversifies, government officials are less likely to be captured by the established fossil fuel industry, thus gaining flexibility in implementing policies that support alternative energy sources.

Figure 1 illustrates this theory. The network on the right represents a real-world concentrated network in which government officials maintain more frequent connections with a specific interest. Compared to a diverse network where decision-makers' connections are evenly distributed across various sectors, government officials in a concentrated network are more prone to being influenced by particular interest groups, resulting in a lower likelihood of implementing national policy. I will elaborate on them in greater detail later.

I argue that China's energy development pattern reflects intricate dynamics and interac-

tions between various socio-economic actors and government officials in different stages of the policy processes. In view of China's central government's strong preference for facilitating renewable energy development, local policymakers should comply with this policy orientation if they are under the influence of a more diverse social network. This theoretical framework generates a related testable implication:

Hypothesis 1: *The diversity of policy network in which local policymakers are embedded is positively associated with renewable energy deployment; the more diverse the network, the higher the renewable electricity capacity.*

By a *diverse network*, I am referring to a local policy network that involves stakeholders from various backgrounds – government officials, energy experts, entrepreneurs, academics, NGOs, private businesses, SOEs, and other social groups – representing the interest of their own sector.

In sum, this theory complements the existing abstract macro-level fragmentation and political survival theory, providing a micro-level foundation and mechanisms through which diverse actors exert their influence on policymaking in the authoritarian context.

Energy Governance System in China

Over the past 40 years, China's fast economic development has been fueled by coal. With China's coal consumption reaching a plateau in 2013 (Qi et al., 2016), it has committed to fueling its future development with low-carbon sources and achieving carbon neutrality by 2060. This means China must integrate more clean energy into its energy system and gradually phase out coal and other fossil fuels. Since 2006, China has initiated a series of energy and climate policies that have successfully cultivated a robust clean energy industry (Zhu et al., 2019). Its investment in renewables grew by over 100 times compared to 2005 and accounts for one-third of global investments in renewable energy today (BP Energy Statistics).

Integrating renewables into the existing fossil-fuel-based energy system, however, creates significant challenges for energy governance. From a technical standpoint, integrating intermittent wind and solar energy requires improving electricity system flexibility and establishing a market mechanism that prioritizes renewable sources. A flexible operating system and interdepartmental coordination are the keys to the success of renewable penetration in developed countries. Unfortunately, smooth coordination and the free market have been luxuries in the "fragmentation authoritarian" governance system of China (Lieberthal and Oksenberg, 1988; Zhou, 2017). Figure 2 summarizes the formal governance structure of the electricity sector in China.

As demonstrated in the upper half of Figure 2, at the central level, multiple government agencies have regulatory authorities over different and sometimes competing aspects of the energy industry. In particular, policy coordination and regulation are the responsibility of the National Energy Administration (NEA); state asset and business management strategies are reviewed and supervised by the State-owned Assets Supervision and Administration (SASAC); technology standards and RD investment plans are issued by the Ministry of Science and Technology (MOST); industrial policies are developed by the Ministry of Industry and Information Technology (MIIT); the authority for monitoring and allocating transmission and distribution costs, and setting electricity wholesale and retail prices is placed in the hands of the Pricing Department of the National Development and Reform Committee (NDRC), and market rules and standard practices for electricity market pilot programs are set by State Grid. Furthermore, in the Chinese context, some semi-official organizations, such as public institutions (shiye danwei) play the role of de facto policymakers and are directly involved in the policy process (Guttman et al., 2021). Due to fiscal, staff, and expertise constraints, government regulators often outsource detailed drafting to energy-related research institutions. For instance, Water Conservancy Hydropower Planning Design General Institute (shuiguiyuan) regularly drafts renewable energy-related policies at the national level. At the provincial level, the Electric Power Research Institute (dianliguihuashejiyuan), a State Grid affiliated research institution, drafts local policies, such as the annual electricity generation and transmission plan.

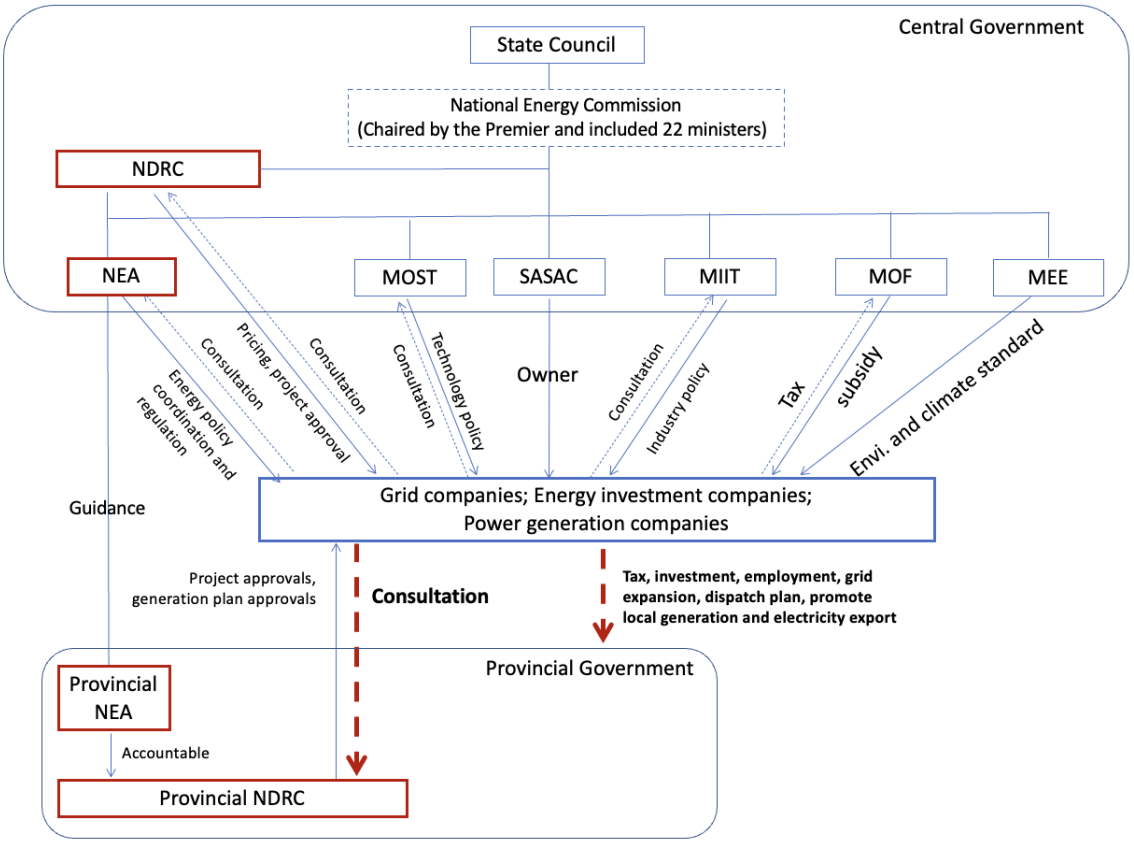

Figure 2: Governance Structure of the Energy Sector in China (Source: Author)

While the central government is in charge of national level decarbonization strategies, the local governments are responsible for initiating detailed energy policy and climate actions. In late 2014, the central government initiated a decentralization reform and delegated the power to approve projects to provincial governments (Alkon and Wong, 2020). As illustrated in the bottom half of Figure 2, under the existing governance system, new energy projects and electricity generation plans are approved locally. Local government officials have strong economic and career incentives to promote energy project construction and electricity generation within their regulatory boundaries (Dai, 2015; Davidson, 2022). Motivated by the Cadre Evaluation System, local government officials, especially those in the energy intensive provinces (such as Inner Mongolia and Shanxi), tend to permit as much generation capacity as possible because the local investment, employment, and tax income depend largely on the energy sector (Ren et al., 2019). Once power plants are built, local governments are also incentivized to promote local electricity generation and export to neighboring provinces (Yuan et al., 2016). The central government, however, has only limited oversight of these decision-making processes

(Alkon and Wong, 2020). For the local government, the real constraints are mostly technical and physical, because electricity demand and transmissions are limited. This "quasi-federal" institutional design, as many scholars have pointed out, creates compliance issues for the authoritarian state. When the energy policy from the central government is inconsistent with the local interest, provincial regulators tend to prioritize the local interests, causing gridlock and delays in policy implementation. To break the gridlock, stakeholders often engage in informal bargaining and networking during the policy processes (Deng and Kennedy, 2010; Lieberthal and Lampton, 1992; Mertha, 2009). Different energy interest groups often need to compete for transmission access and market demand, which creates strong incentives for the energy project developer to engage in networking strategies.

As illustrated in Figure 2, stakeholders can also influence the decision-making processes by providing policy consultation and feedback. Since the 2000s, under the model of "Scientific Outlook on Development," government agencies are required by party rules and laws to perform evidence-based policymaking by engaging in policy deliberation and consultation with industry experts and scholars. In terms of energy governance, local governments rely more heavily on expert input because of technological complexity. High-ranking SOE leaders and experts are often involved in the policy processes as advisors (Gallagher and Xuan, 2019). Figure demonstrates this process. Underlined in red in this announcement, the Energy Administration asked for comments and inputs specifically from major energy companies, grid operators, industry-affiliated business associations, and public institutions.

Exploiting the fragmented governance system, the energy industry utilizes its near monopoly over technological expertise for its own interests. The relationship between the State Grid Cooperation and provincial governments illustrates such inter-dependency. As a key stakeholder and a natural monopoly, the State Grid Cooperation is responsible for grid technology development, grid construction, electricity transmission, distribution, and retail. State Grid, therefore, has a strong influence on energy policy (Xu, 2017). During electricity decentralization reform in 1997, State Grid successfully prevented itself from being broken into five regional grid companies by taking advantage of its structural position in the policymaking process. Later

in the 2000s, State Grid even strengthened its monopoly power by developing and deploying the Ultra-high Voltage (UHV) transmission system that further increased the connectivity of regional grid systems (Xu, 2017). Many experts and government officials blame State Grid for delaying renewable energy development and government actions for combating climate change. [1]

Meanwhile, the deficit in regulatory capacity also opens doors for other social actors to exert influence on the policy processes. Academics are especially active in the fields of energy, environment, and climate change. Some have direct access to key decision-makers or even top leaders. In addition, even though mass participation is rarely allowed in an authoritarian regime, environmental NGOs can still find space in the energy policy arena. At the central level, experts from NGOs and thinktanks, including the US- and Europe-based ones, such as the Energy Foundation, Green Peace, Natural Resource Defense Council, and the Heinrich Böll Foundation, are actively engaged in policy processes indirectly as advocates for green energy and advisors for government regulators. To maximize their connections with policy-makers, NGOs often employ retired government officials or highly influential scholars with strong government connections as their managers. Table 1 summarizes the policy actors and their competing objectives in the energy policy.

Table 1: Major Policy Actors and their Competing Objectives.

Policy actors		Primary Objectives
Central government	→	Climate mitigation
Provincial government	→	Infrastructure investments and local electricity production
Industry consumers	→	Cheap electricity rate
State Grid	→	Electric system reliability
Public Institutions and NGOs	→	Climate mitigation and local air quality
Renewables and coal investors	→	Higher market share

[1] Author's interview 201607.

国家能源局综合司文件

国家能源局综合司关于征求《可再生能源电力配额及考核办法（征求意见稿）》意见的函

财政部、国资委、生态环境部、审计署办公厅，各省、自治区、直辖市、新疆生产建设兵团发展改革委（能源局）、经信委（工信委、工信厅），国家能源局各派出监管机构，国家电网公司、南方电网公司、内蒙古电力公司，华能、大唐、华电、国能投、国电投集团公司，电力规划设计总院、水电水利规划设计总院、相关行业协会（联盟）、国家可再生能源中心：

为全面贯彻党的十九大精神，推动能源生产和消费革命，促进生态文明建设，依据《中华人民共和国可再生能源法》，我们组织研究起草了《可再生能源电力配额及考核办法（征求意见稿）》及其编制说明。请你单位结合职能研提意见，并请于3月30日前将书面意见反馈我局新能源司。

联系电话：010-68555030 传真：010-68555045

附件： 1. 可再生能源电力配额及考核办法（征求意见稿）

2. 可再生能源电力配额及考核办法编制说明

国家能源局综合司

2018年3月23日

Letter from the General Division of National Energy Administration about Seeking Feedbacks on the *Renewable Energy Quota Allocation and Assessment Rules (Draft for comments)*

Ministry of Finance, State-owned Assets Supervision and Administration Commission, Ministry of Ecology and Environment, National Audit Office, Development and Reform Commission (Energy Bureau) of each province, local office of the National Energy Administration, State Grid Cooperation, Southern Grid Cooperation, Inner Monglia Electric Company, Huaneng Group, Datang Corporation, Huadian Group, China Energy Investment, China Power Investment Corporation, Electric Power Planning Design General Institute, Water Conservancy Hydropower Planning Design General Institute, concerned business associations (alliances), National Renewable Energy Center:

For the comprehensive implementation of the spirit of the 19th Party Congress, promote energy production and consumption revolution, promote ecological civilization construction, according to the "Renewable Energy Law of the People's Republic of China", we drafted *the Renewable Energy Quota Allocation and Assessment Rules (Draft for comments)*, as well as its preparation instructions. Please provide us feedbacks and comments accordingly, and return written comments to our office by March 30th, 2018.

Attachment: 1. *Renewable Energy Quota Allocation and Assessment Rules (Draft for comments)*
2. Preparation instructions for the *Renewable Energy Quota Allocation and Assessment Rules*

General Division, National Energy Administration
March 23rd, 2018

Figure 3: Request for Comments and Inputs on the "Renewable Electricity Quota and Assessment Method" by the National Energy Administration. Source: http://zfxxgk.nea.gov.cn/auto87/201803/t20180323_3131.*htm*(*accessedApril*6, 2022)

Renewable Energy Development in China and its Challenges

China is the world's largest investor in renewable energy. Since 2006, China has adopted numerous policies to promote renewable installation. During China's 11th and 13th Five-Year-Plan (2006 – 2020) period, wind and solar energy installation surged from 1.26 GW and 0.07 GW in 2005 to 281 and 252.5 GW in 2020, respectively. In 2021, the 14th Five-Year-Plan of Wind Power Development set the installation target at 100 GW with at least 190 billion kWh of electricity generated from wind by 2025. Financially, China's Ministry of Finance issued *The Temporary Rules on Fit-in-Tariff of Renewable Energy (2007)*, which promises subsidies for renewable power generation. Along with various administrative endeavors by local and central governments (Dai and Xue, 2015; Kang et al., 2012), these policies have successfully boosted wind and solar power installation to 328 and 306 gigawatts in 2021, representing nearly half of the total global installation. Echoing the 25 percent target of non-fossil energy consumption in 2030 under the Paris Accord Climate Agreement, the National Energy Administration (NEA) proposes a renewable energy quota scheme, suggesting that at the minimum, 26 percent of power generation should come from non-hydro renewable energy in 2030. As a result, China's non-hydro renewable energy consumption increased rapidly and reached over 14 percent of its total electricity consumption in 2021.

While China's approach successfully facilitated a strong wind and solar industry and made it the front runner in renewable installations and generation, its decarbonization path nonetheless faces significant challenges. Curtailment of renewable electricity generation – the abandonment of electricity generation of effective power capacity – has become part of the "New Normal" as wind and solar installation expand across the country. For wind energy in particular, from 2010 to 2020, 248.5 million megawatt hours (MWh), or as much as 10 percent of overall wind generation, was abandoned. Figure 4 shows the overall wind generation and curtailment from 2010 to 2020. The opportunity cost associated with wind power curtailment in China is estimated to have reached about 2 billion US dollars. The total energy loss is equivalent to 80 million tons of coal consumption, or 221 million tons of CO2 emissions, which is equivalent to about 2 percent of China's total emissions in 2020.

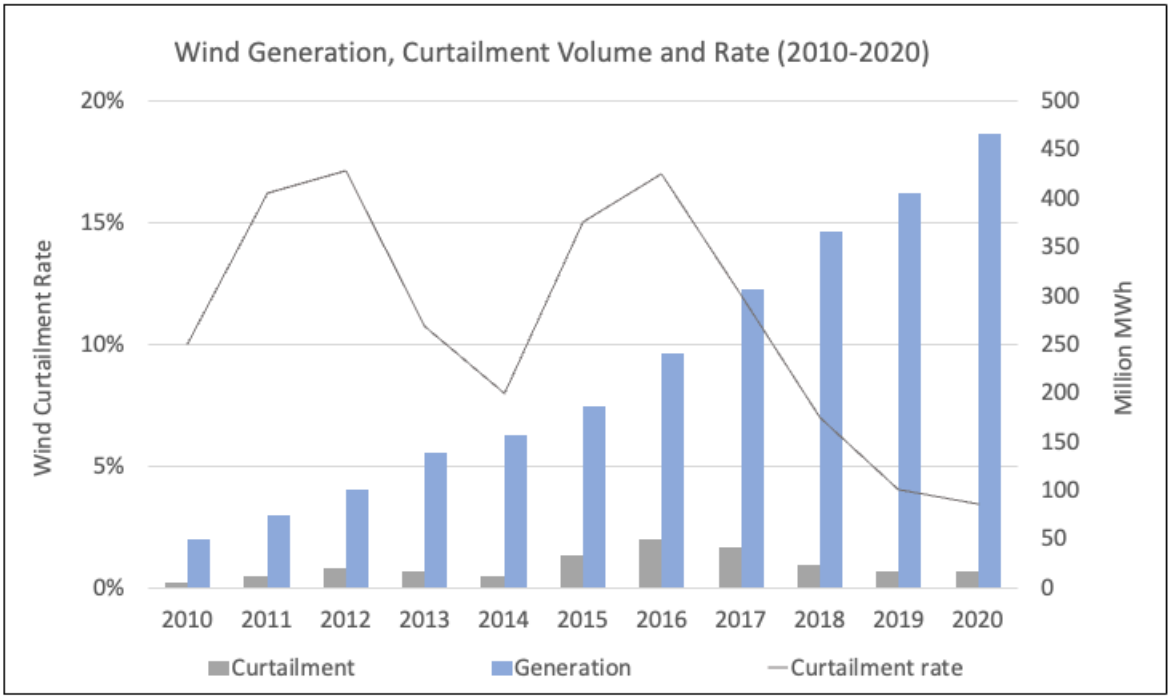

Figure 4: Wind Installation Capacity and Curtailment (2010-2020) (Data source: Chinese Bureau of Statistics and National Energy Administration)

Technically, curtailment happens when grid operators command facilities to reduce output to maintain system balance and reduce transmission congestion. Ceteris paribus, a common cause of wind curtailment, is high wind speed. High wind speed could create challenges for grids, especially the small and isolated ones that lack flexibility, when wind farms produce excess electricity during off-peak hours that could cause baseload power plants to hit minimum generation capacity. Compared to the 1 to 4 percent average curtailment rate in the United States and Europe, China's situation is hardly a mere technical problem.

The renewable curtailment issue was first observed in the North, Northeast, and Northwest of China or the so-called "Three Norths" region, where most of the national wind resource and more than 60 percent of wind power deployment is located. Figure 5 demonstrates wind curtailment across China in 2016. In Gansu, for instance, wind curtailment went up from 11 percent in 2014 to 43 percent in 2016. This means that Gansu only utilized 57 percent of installed wind capacity in 2016. Wind curtailments impose losses on local renewable developers. For example, on September 28, 2015, a windy day in the Jiuquan City of Gansu, wind farms owned by

Huaneng Renewable Energy Group experienced a 79 percent wind curtailment rate. [2] Over 13 million kWh wind electricity was abandoned within 24 hours, equivalent to a 600 million yuan loss for Huaneng. [3] Frequent curtailments mean not only that wind farms would not receive payment for electricity generation and associated subsidies, but also damage to wind turbines that shorten their lifespan by up to five years (Lu et al., 2016).

In response to shrinking revenue, the renewable industry has been complaining about the curtailment issue at the provincial and national levels. Many firms act in groups to strengthen their bargaining power with the government. For instance, in January 2016, the renewable branch of the "Big Five" electricity generation companies (Huaneng, Huadian, Guodian, Datang, and China Power Investment Corporation) co-authored a joint petition to the national and provincial energy administration, demanding government actions to increase renewable utilization. In addition, individual energy firms also convey their request to regulators through industry associations to the regulators. The wind renewable association filed an administrative review and a lawsuit against local governments and State Grid on behalf of wind investors. [4]

Renewable energy curtailments also caught the attention of non-state social actors. NGOs, think tanks, and scholars actively engaged with local governments and the grid operator to seek possible solutions. For instance, in 2016, the Paulson Institute in Beijing (a US-based think tank), in collaboration with NEA and NDRC, released a series of reports and hosted three roundtable events about renewable penetration. According to the organizer, these efforts aim to promote decarbonization and to "provide an open and transparent platform for dialogue within a diverse group of policymakers, industry experts, enterprises, researchers and NGO representatives." [5] Engagement and interactions like these often result in policy actions. Social actors and renewable investors also worked with government officials to propose policies for solving curtailments through the People's Congress and the People's Political Consultative

[2] Author's interview 2016081.
[3] ibid.
[4] Author's interview 2016031.
[5] Paulson Institute Report Recommends Jing-Jin-Ji Region Become a Renewable Energy Integration Zone. July, 2016. Source: https://www.paulsoninstitute.org/pressrelease/paulson-institute-report-recommends-jing-jin-ji-region-become-a-renewable-energy-integration-zone/.

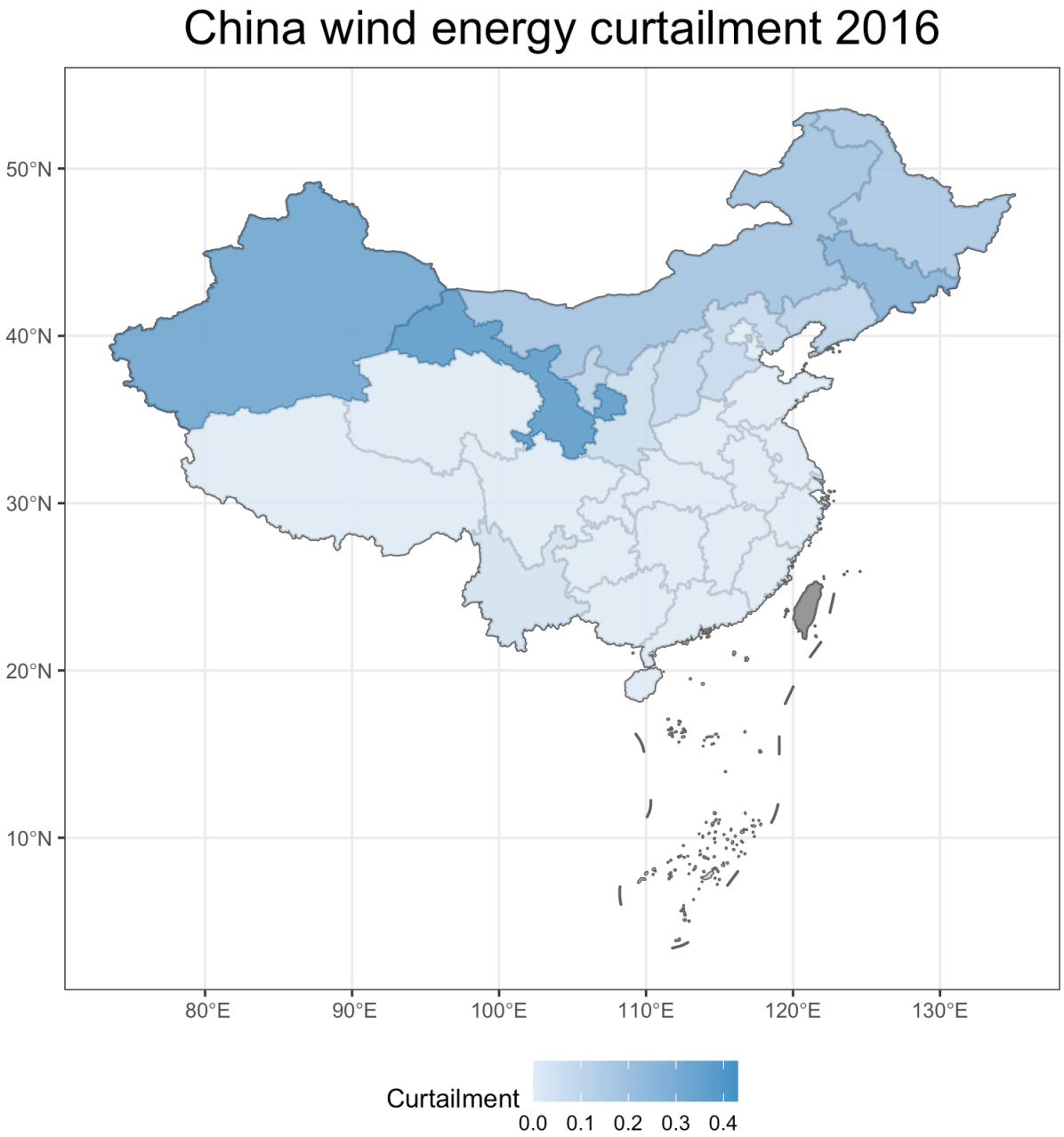

Figure 5: Wind Energy Curtailment in China, 2016 (Data source: National Energy Administration, graph made by the author)

Conference, such as the Renewable Portfolio Standard and Renewable Energy Certificates. [6] As such, the curtailment crisis created strong networking activities for different stakeholders and social actors.

If the curtailment issue continues to be unsolved, then renewable investors could also directly pressure local governments by withdrawing investment or temporarily exiting the market. Local government, in response, would actively seek solutions to reduce curtailment to attract investments. The energy governance reform in late 2014, however, significantly changed this dynamic. With the newly granted project approval right, local governments could pressure renewable developers to continue investing regardless of local conditions. For instance, in Gansu, the provincial government threatened to suspend construction licenses if investors did not fulfill their planned target in the current investment cycle. [7] As a result, it has become more likely that renewable investors act on the threat and exit the market. Since 2015, many renewable developers have shifted their investments from the wind rich-areas in Northeast and Northwest regions to the South to avoid losses from curtailments.

Data

Mapping the Policy Community

My main explanatory variable for policy network diversity is the extent to which policymakers are embedded in a pluralistic policy network. In this chapter, to identify the structure of policy networks, I collect original data on the policy communities at the provincial level using an event-based approach. Nodes in the network contain the following three kinds of individuals:

- Individuals featured in policy-oriented public events/conferences hosted by different organizations, such as policy meetings organized by China's Energy Bureau, climate-related conferences, and public events sponsored by public institutes, NGOs, or business

[6] Author's interview 2016082.
[7] Author's interview 2016083.

associations;

- Individuals who co-authored published products, including policy briefs, industrial reports, or other forms of policy documents;
- Individuals who participated in energy or climate-related government task forces or committees.

Ties are defined as either co-attendance of conferences or co-authorship of policy products. In other words, participants are included in the study population if and only if they co-attend at least one conference or co-author at least one policy product with another. The relationship (edge) between two individuals is defined as the number of conferences attended or policy documents issued with each other in a particular time frame. While other forms of connections (often unobservable) may also exist, the observable network should closely approximate the real network in terms of the representation of sectorial interests, thereby serving as a representative proxy for the actual network. Furthermore, I coded notes' attributes based on their affiliations. The data covers the years 2014-2019. A total of 28 policy communities are included in the data. A network is constructed for every year, with the network size varying from 50 to 350 nodes over six years.

The event-based approach has two advantages compared to other measures of networks. First, it avoids false positive accounts of interactions. If policy actors' interactions are publicly observed, they will likely share the tie behind the scenes. Second, even though some measurement errors might not be fully accountable, this measure of network structure should be highly correlated with the true connections between policymakers and policy actors.

Measuring Diversity

As defined in the previous section, network pluralism comes from the diversified interests and perspectives of participants. I thus also collected data on these individuals' affiliations and coded and aggregated them by sectors. Figure 6 demonstrated the data aggregation process using a real-world example. I use the distribution of sector categories to calculate network

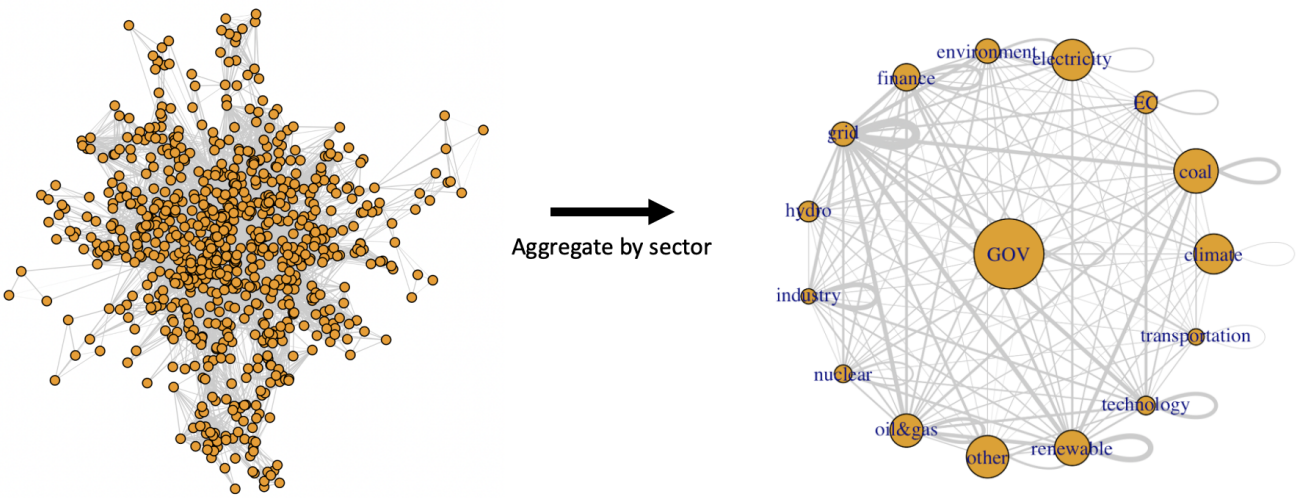

Figure 6: The data aggregation process (Source: Author)

diversity (ND), using the standardized Herfindahl– Hirschman index:

$$ND = 1 - \sum_{c=1}^{C} S_c^2 \tag{1}$$

The measure can be interpreted as the probability that two randomly selected individuals who share connections with government officials are from different energy sectors. This approach allows me to account for the overall configuration of diverse interests in the province and differences in relative size or strength of different policy orientations and preferences.

The main outcome variable, the level of renewable development, is measured as total wind installation and the share of wind in the electricity supply. These energy related data are mostly available in *China Energy Statistical Yearbook*. Additional control variables include GDP per capita, urbanization rate, industrial structure (percentage manufacturing), government tax revenue, and total energy consumption, obtained from China's National Bureau of Statistics.

Identification strategy

For the statistical analysis, I start by using the ordinary least squares (OLS) regression to model renewable energy development as a function of network diversity. OLS estimates, however, could suffer from endogeneity bias in this context for three reasons. First, my estimate of network diversity could suffer from measurement errors that might be correlated with residuals. Second, omitted variables could influence both network diversity and renewable energy development within a given province, resulting in a biased estimated effect of network diversity. Third, the estimated effect of network diversity could be biased due to reverse causality, as the policy network could be diversified as the level of renewable energy increases.

To obtain an unbiased estimated effect of network diversity, I would want the level of diversify of a policy network to be randomly assigned to a given province so that it is uncorrelated with other characteristics. To identify the overall causal effect of network diversity, this research implements two empirical strategies, fixed effects and instrumental variables, both relying on cross-provincial panel data. I first use an extensive set of covariates to control for confounds that could explain both the network diversity and the level of renewable development. I include the curtailment level as a covariate to control for the electricity system's flexibility. Provincial air quality, specifically the annual average PM2.5 concentration level, is also incorporated as a control variable. This allows for the assessment of an alternative hypothesis: that local governments pursue the development of renewables primarily with the intention of improving air quality. I also control for economic factors that determine provinces' preference for energy investment. They include log GDP per capita, manufacturing as a percentage of GDP, and log total energy consumption. The other controlled socio-political factors include urbanization rate, estimated as the proportion of the population living in urban areas, log government tax income, and curtailment level. Second, I include provincial fixed effects, which control for many time-invariant factors that affect network structure and renewable development, such as natural resource endowment, size of the territory, proximity to electricity demand centers, and long-term climate factors. Controlling for these time-invariant confounds is critical to causal inference because they could affect the economic attractiveness of provinces to energy devel-

opers and their incentives for networking activities. In addition to district-fixed effects, I also include year-fixed effects to control for the impact of country-wide shocks – such as national climate and energy policies – on both the independent and dependent variables. A time trend variable is also included in the model to remove the effects of global time-variant trends and control for temporal heterogeneity, such as the decreasing cost of wind energy.

The fixed effects regression model builds on the following specification:

$$Y_{it} = \alpha_0 + \delta_i + \gamma_t + \alpha D_{it} + \gamma^T X_{it} + \varepsilon_{it} \tag{2}$$

where Y_{it} denotes the renewable energy development in province i at time t. Parameter α_0 is the intercept, δ_i and γ_t each represent the provincial fixed effects and time fixed effects, and X is a series of time-varying control variables. α is the treatment effect of network influence.

But the main challenge to causal inference using the fixed effects model is time-varying omitted variables that change disproportionally across different provinces in the treatment and control groups. In this context, two of the most obvious unobservable omitted variables are closed-door decision-making and corruption. As discussed in the previous paragraph, the fixed effect model also could not solve the measurement error and reverse causality issue. Therefore, I adopt an instrumental variable approach to further address the endogeneity problems.

The instrumental variable is computed as the renewable potential in a given province. In particular, I use the annual average wind speed from previous years as an instrument for networking activities (data available from *China Meteorological Data Service Center*). As discussed in the previous section, this instrument exploits the nature of the renewable system and assumes higher wind speeds that caused poor renewable electricity utilization as an exogenous shock, which calls for the intensification of networking of renewable and climate policy actors. The causal logic of the instrumental variable is that strong wind could cause renewable energy curtailment, which in turn reduces profits for renewable developers. Figure 7 plots the relationship and confirms that wind speed is a robust predictor of the curtailment level. I contend that

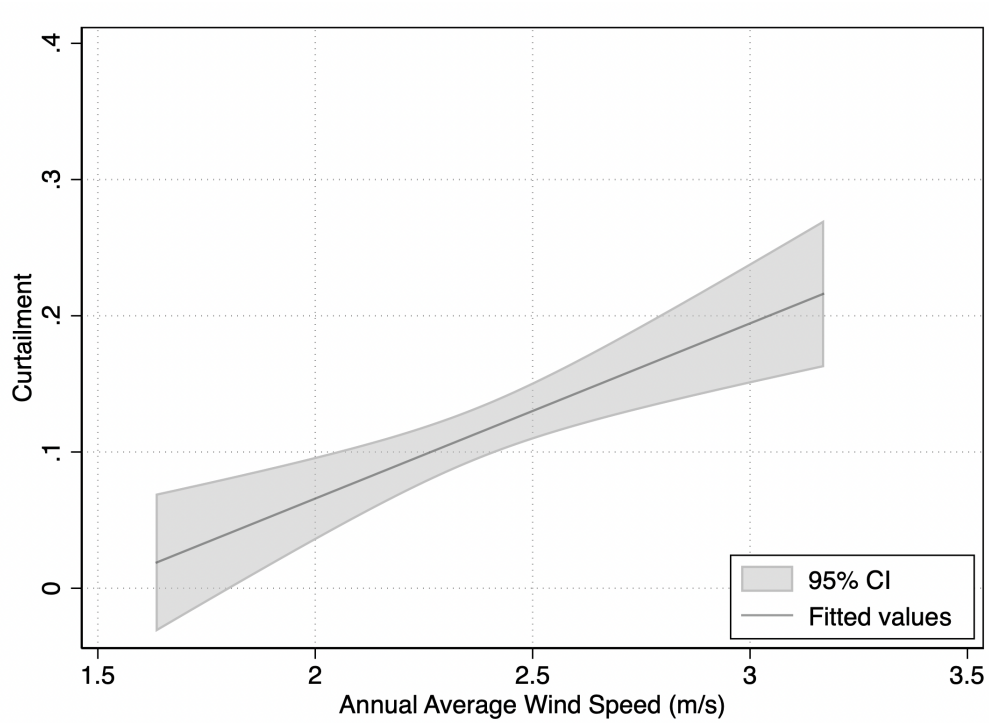

Figure 7: The relationship between annual average wind speed and curtailment level, with 95% confidence intervals.

the exclusion restriction assumption holds in this case, because the wind speed from previous years in the same province is unlikely to directly affect the dependent variable in the current year. The causal effect is estimated using two-stage least squares (2SLS) regression:

$$D_{it} = \pi_0 + \delta_i + \gamma_t + \pi_1 Z_{it} + \beta^T X_{it} + \mu_{it} \tag{3}$$

$$Y_{it} = \alpha_0 + \delta_i + \gamma_t + \alpha_1 D_{it-n} + \beta^T X_{it} + \varepsilon_{it} \tag{4}$$

where in the first stage, D_{it} represents the treatment variable, calculated using the instrument, Z_{it}, along with provincial and time fixed effects, δ_i and γ_t, as well as other covariates X_{it}. In the second stage, the dependent variable Y_{it}, i.e., renewable development, is predicted by the modeled value of treatment in stage one. This strategy relies on the exclusion restriction assumption ($Cov[\varepsilon_{it}, Z_{it}] = 0$). Regarding the context of renewable energy development, it assumes that conditional on year and provincial fixed effects, wind speeds in previous years have no direct effect on the renewable development of province i at time t. This assumption is plausible because cur-

tailments from the previous year should intensify networking but are not themselves caused by regional progress in renewable construction. Also, the short term wind speed change does not influence wind farm construction directly, because investment companies pick sites based on historical weather records that cover 30 to 50 years of local meteorological condition, which is controlled by local fixed effects since local weather do not change drastically in the long term. As such, I will be able to claim causality in this study.

Empirical Findings

Fixed Effects Panel Regression

This section examines whether network diversity has a causal effect on decarbonization. Table 2 presents the result of the pool-OLS and fixed effects models using the continuous measure of network diversity. The effect of network diversity is robust across all specifications. As shown in Models 1 and 2, the coefficients reveal a positive and statistically significant correlation between network diversity and renewable energy development using two different measurements. Models 3 and 4 use a fixed effects estimator with time fixed effects. The coefficient of the main explanatory variable in Model 5 and 6, which includes both province and year fixed effects and control variables, suggests that a one-standard deviation increase in network diversity (0.025) is associated with an increase of 5.1 percentage points in the share of wind capacity in the energy structure or 6.3 percent in the total installation of wind capacity. Here, the air quality variable does not yield a significant result. This suggests that the motivation for developing renewable energy does not primarily design to control air pollution.

Considering local protectionism, network diversity should be less effective in provinces dependent on the coal economy. Recall that at the local level, governments have the incentive to maximize all project constructions. Even though local policymakers could be captured by the coal interest, they also would encourage renewable installation, only on smaller scales compared to those less coal-dependent provinces. Empirically, coal dependency could be measured

Table 2: The effect of network diversity on renewable energy development (2015-2019).

	(1) Wind share	(2) Wind installation	(3) Wind share	(4) Wind installation	(5) Wind share	(6) Wind installation
Network Diversity	2.057***	1.945**	2.220***	2.396***	1.977**	2.512**
	(0.648)	(0.766)	(0.687)	(0.802)	(0.664)	(0.833)
Observations	130	130	130	130	130	130
R-Square	0.023	0.016	0.283	0.340	0.353	0.430
Time FE	No	No	Yes	Yes	Yes	Yes
Province FE	No	No	Yes	Yes	Yes	Yes
Other Controls	No	No	No	No	Yes	Yes
Number of prov			26	26	26	26

Robust standard errors in brackets *** p<0.01, ** p<0.05, * p<0.10.

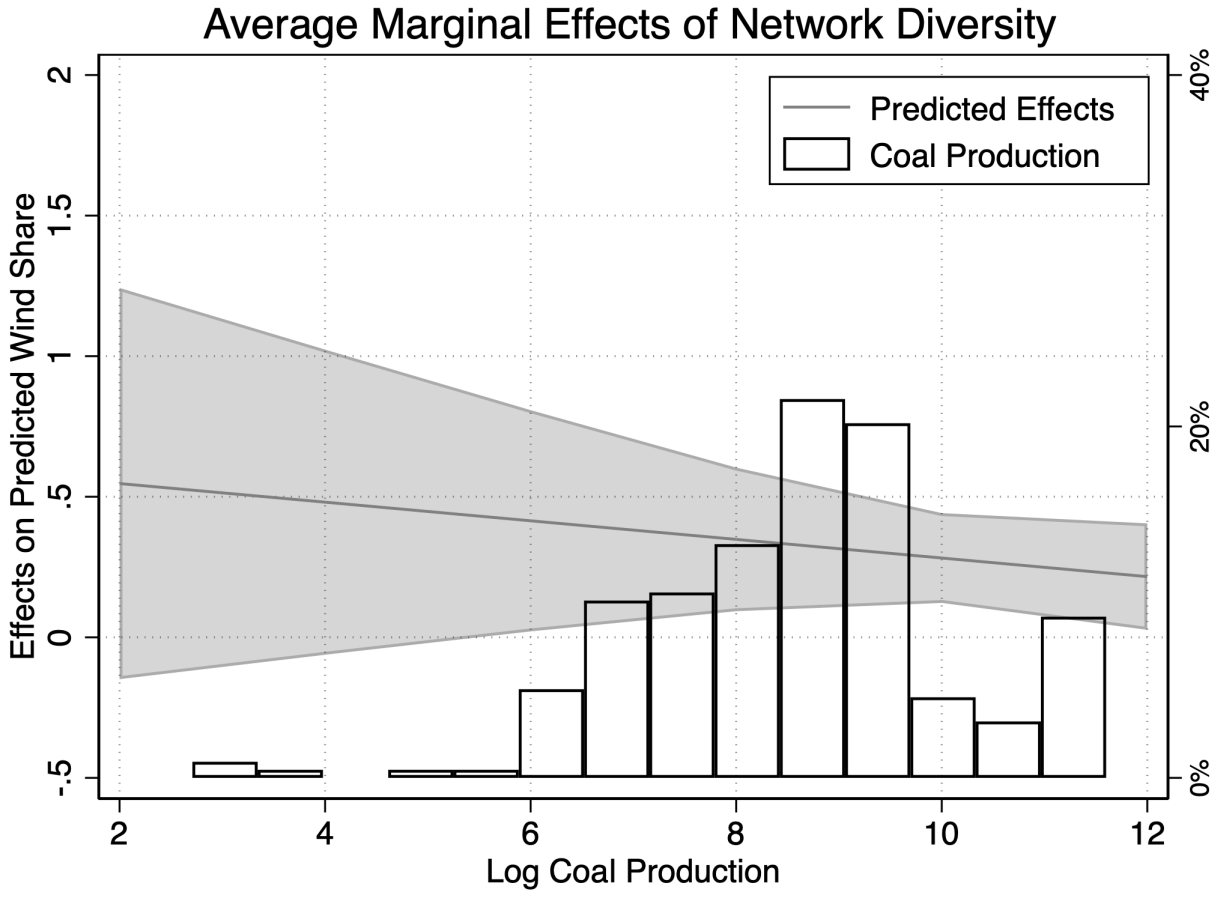

Figure 8: The Marginal Effect of Network Diversity Condition on the Level of Coal Production.

as the level of coal production. I reveal this effect by interacting the main explanatory variable with the log level of coal production. Figure 8 demonstrates the marginal effects of network diversity at different levels of coal production and the distribution of coal production. The plot

suggests that network pluralism has no discernible effect on renewable development at low levels of coal production, which is less than 8% of observations with log coal production level rates below 5, and the marginal effect of diversity decreases as the level of coal production increases.

Instrumental variable approach

In Table 3, I present the main result of this chapter. The upper panel of Table 3 shows the second-stage results of the 2SLS approach, and the signs of coefficients of network diversity are consistent with the fixed effect estimates. These models employ instrument decarbonization by using two lags of wind speed. With the full control set, Models 3 and 4 suggest that the average treatment effect of network diversity is positive and increasing network diversity by one standard deviation will speed up wind share and wind installation by 16 percent and 19 percentage, respectively. This result remains robust after including more control variables. This once again suggests that the causality is robust. The first-stage F-statistics are above the conventional threshold (10) across all models. This suggests that the instrument is valid.

Table 3: Wind speed as an instrument for network diversity on renewable development.

	(1) Wind share	(2) Wind installation	(3) Wind share	(4) Wind installation
Network Diversity	5.615** (2.630)	7.147 *** (3.142)	6.309*** (2.634)	7.580*** (3.136)
	First Stage Estimate			
Windspeed, 1^{st} lag	-0.068 (0.057)	-0.068 (0.057)	-0.078 (0.056)	-0.078 (0.056)
Windspeed, 2^{nd} lag	0.105*** (0.031)	0.105 *** (0.031)	0.099*** (0.029)	0.110*** (0.040)
Observations	130	130	130	130
R-Square	0.217	0.283	0.224	0.308
Time FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Other Controls	No	No	Yes	Yes
First stage F-statistics	10.5	10.5	12.5	12.5
Number of prov	26	26	26	26

Robust standard errors in brackets *** p<0.01, ** p<0.05, * p<0.10.

In sum, the IV strategy suggests that an increase in network diversity has a significant positive impact on renewable energy development. Being embedded in a more diverse network will improve the energy structure and renewable energy deployment. Here, notice that the IV estimate is three times higher than that of the fixed effect estimate. I find this high positive is plausible given the IV variable estimates the local average treatment effects, in which the instrument shifts the policy preference of a subset of provinces that diversified over the years, while the fixed effects estimate (or at least try to) the average treatment effect over the entire population. Empirically speaking, this makes sense because not all provinces have experienced a significant change in terms of annual average wind speed. Nevertheless, this positive relationship between diversity and renewable development is robust and causal.

Robustness Checks

The OLS results suggest that network pluralism has a positive impact on the level of renewable energy development, measured in the proportion of wind capacity in the energy mix and total wind installed capacity, and the 2SLS results confirmed that the effect is causal. This section provides robustness tests for the OLS results and robustness tests of the identification strategy using an alternative measurement of renewable development and two placebo tests. The test results are summarized in table 4 and table 5.

First, an alternative explanation to consider is that within diverse networks, policy actors associated with wind or solar sectors might maintain stronger connections with policymakers. Consequently, it may not be diversity driving the results, but these robust ties with renewable sectors. In other words, the policymakers could be influenced not by the fossil fuel industry, but by the renewables. To test this alternate explanation, I use the proportion of policy actors from the wind industry within the network as the independent variable. As demonstrated in table 4, the mere presence of wind sector actors does not correlate with wind development across all models. The results suggest that the decarbonization process is not a simple interest competition. The renewable industry alone can not change the power structure and prevent

local capture.

Table 4: The effect of wind actors' presence on wind development.

	(1) Wind share	(2) Wind installation	(3) Wind share	(4) Wind installation	(5) Wind share	(6) Wind installation
Wind Actor Share	0.019	0.311	0.0003	0.260	0.441	0.422
	(0.500)	(0.560)	(0.569)	(0.668)	(0.582)	(0.687)
Observations	130	130	130	130	130	130
R-Square	0.000	0.258	0.000	0.312	0.332	0.401
Time FE	No	No	Yes	Yes	Yes	Yes
Province FE	No	No	Yes	Yes	Yes	Yes
Other Controls	No	No	No	No	Yes	Yes
Number of prov			26	26	26	26

Robust standard errors in brackets *** p<0.01, ** p<0.05, * p<0.10.

Second, for the IV strategy, I start with an alternative measure of the dependent variable. As discussed in the previous section, developing renewable energy also means slowly replacing and phasing out conventional energy, which includes coal and large hydro unit. Although hydropower is also a form of renewable energy, it is an old technology that China has mastered for over 80 years. But sitting and technological characteristics make its environmental and climate impact much greater than that of wind and solar, limiting hydro's potential for a net-zero future. As such, shifting the energy structure away from coal and hydropower is consistent with the central government's decarbonization strategy. Therefore, I adopt an alternative measure of the dependent variable in terms of the structural share of coal and hydro capacity, and I expect the coefficient of network diversity to turn negative and statistically significant. Model 1 presents the result of this strategy. As expected, the estimated effect of network diversity negatively correlated with the conventional capacity.

Third, I also present two placebo tests for the effects of network pluralism by examining the effect of provincial network diversity on nuclear energy development. Even though the Chinese government deemed nuclear energy a valid source for decarbonization, the central government is cautious about installing nuclear power in non-coastal regions, especially after the Fukushima nuclear incident in 2013. Due to security and environmental concerns, the project approval right for nuclear electricity plants is held tight by the central government. Therefore, local

Table 5: Robustness tests for the causal effect of network diversity.

	(1) Coal and hydro	(2) Nuclear share	(3) Nuclear installation
Network Diversity	-0.521** (0.256)	-1.621 (1.252)	-1.613 (1.415)
Observations	130	104	104
R-Square	0.243	0.068	0.087
Time FE	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes
First stage F-statistics	12.5	12.4	12.4
Number of prov	26	26	26

Robust standard errors in brackets *** p<0.01, ** p<0.05, * p<0.10.

networking activities and network structure should not affect nuclear development at the local level. In Model 2 and Model 3, I measure nuclear energy development using the share of nuclear capacity in the energy structure and the absolute amount of nuclear installation as the dependent variable. As expected, the level of network diversity does not have a statistically significant effect on nuclear energy development.

Quantitative Evidence on the Mechanism: Threat to Exit

Although the main focus of the empirical sections is to identify the causal effect of network pluralism on renewable development, my theory suggests that policy actors could influence policy by utilizing their structural position in the network. Since the energy industry has been an important taxpayer and investor, many energy firms use the threat of exit to strengthen their bargaining position with regulators. In the case of renewable development, renewable firms threaten to reduce investment or invest somewhere else if local governments are not able to solve the curtailment issue. The regulatory structural reform in late 2014, however, significantly increased the bargaining power of the local government. Renewable investors are, therefore, more likely to act on the threat if curtailments happen.

I utilize the 2014 reform as an exogenous shock to identify the causal effect of curtailment

Table 6: The effect of project approval right decentralization on wind investment (2012-2019).

	(1) Wind installation	(2) Wind installation	(3) Wind installation
Post-2014	1.505***	2.436 ***	-0.150
	(0.207)	(0.275)	(0.237)
Curtailment	12.297***	7.136 ***	2.925***
	(1.989)	(1.234)	(0.788)
Post-2014 × Curtailment	-6.671***	-5.426 ***	-1.804***
	(2.135)	(1.021)	(0.644)
Observations	208	208	208
R-Square	0.428	0.777	0.923
Time FE	No	Yes	Yes
Province FE	No	Yes	Yes
Other Controls	No	No	Yes
Number of prov		26	26

Robust standard errors in brackets *** p<0.01, ** p<0.05, * p<0.10.

on renewable investment. Here, I use the intensity of curtailment as the percentage of abandoned wind electricity. As Nunn and Qian (2011) point out, using a continuous measure of the intensity of treatment allows me to capture more variation in the data. Table 6 presents the DID estimate with curtailment as continuous treatment and standard errors clustered at the provincial level. Model 1 is the baseline model without any fixed effects and controls. The coefficient of the interaction term is negative, which is consistent with the theory. Model 2 includes time and provincial fixed effects, and the full model (column 3) adds both fixed effects and other control variables. The coefficients of the interaction term in both models remain negative. The coefficient in Model 3 indicates that a one standard deviation increase in wind energy curtailment (0.086) will reduce wind investment by 15.6% compared to the pre-2014 period.

Figure 9 plots point estimates from column 3 in Table 6 for each year from 2012 to 2019. The figure lends strong support to the theory. It shows a strong increasing trend from 2012 to 2014, but it was immediately reversed after the regulatory restructuring. Notice that there is a significant positive association between curtailment and investment prior to 2017. This is likely because curtailment usually happens in areas with rich wind resources, which also tend to attract investments. When renewable developers are in a better bargaining position, they

tend to have confidence in the return of investment over time since the local governments are more likely to respond to their requests and actively mitigate the curtailment issue. But as their bargaining advantage fades away due to the reform, firms are more likely to reduce investment in those provinces or even exit the market if curtailment happens.

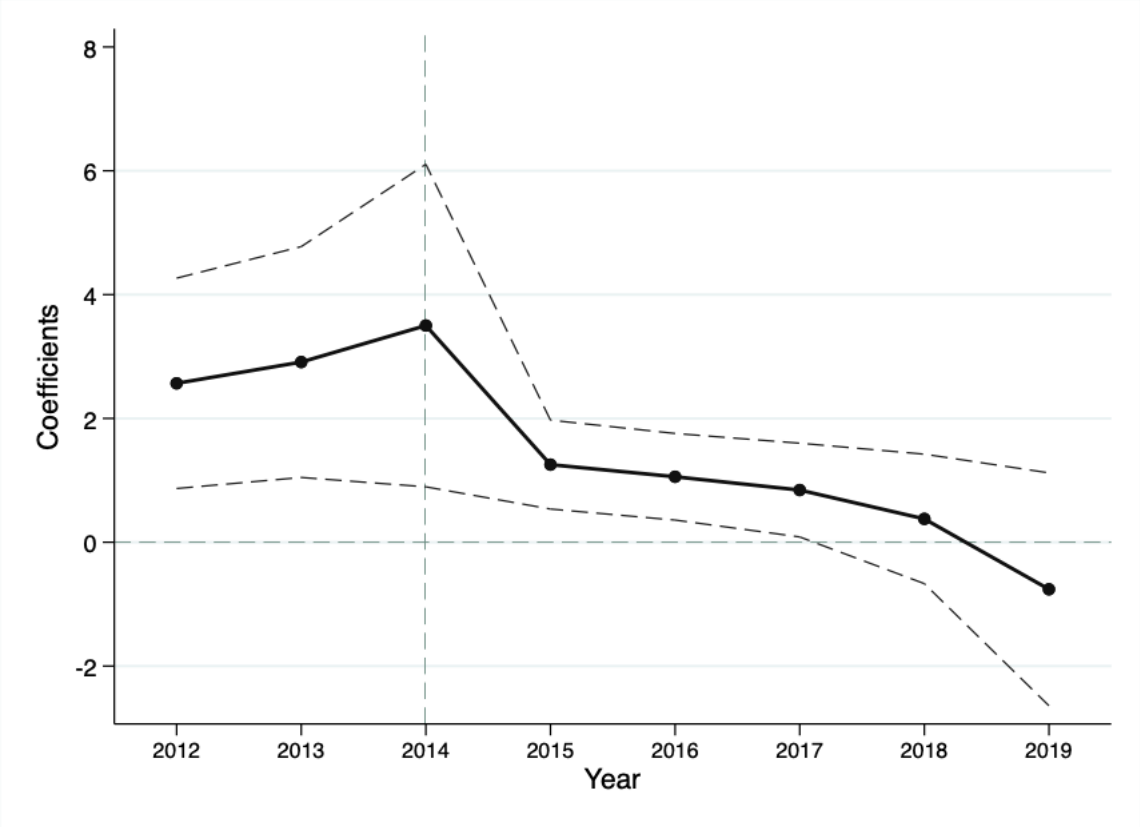

Figure 9: Flexible Estimates of the Relationship Between Wind Curtailment and Wind Investment.

Qualitative Evidence on the Alternative Mechanism: Deliberative Influence

I also employ qualitative interviews to explore how policy actors influence decision-making through deliberation. From 2015 to 2018, I conducted field research in Beijing, Gansu, Shannxi, Yunan, Guizhou, and Guangdong. I interviewed stakeholders and policy actors in the energy industry, including regulators, firm and business association managers, energy experts from NGOs and think tanks, and academics. This section does not provide causal inference on

the effect of the alternative mechanism; instead, it sheds light on the quantitative evidence and provides a practical understanding of policy processes in China. Drawing on the interviews, I confirm that policy actors influence policymaking through formal and informal channels.

My interviews with energy experts from the business sector and non-governmental sectors reveal that some policy actors can directly influence the decision-making processes through persuasion. As indicated in previous sections, experts can participate in the policy process by providing consultation as advisors. Many NGOs and think tanks also hold public or closed-door conferences that involve different stakeholders. They engage in the process by hosting public events and close-door seminars that feature government officials and the business sector. Also, academics, NGOs, and think tanks invite government officials and other policy actors to publish policy-relevant research, providing intellectual support for evidence-based policymaking. My interviews with government officials suggest that they often take these opinions seriously. As one senior official from the National Energy Administration told me: "We need substantial research evidence to back our policy in order to make them credible. We keep a close eye on experts' voices out there. If anyone raises a novel and good study, we will invite them over to discuss specific issues...after all, this [the energy field] is a small circle."

The decision-making process of the carbon neutrality policy reflects these dynamics between social actors and the government. In 2020, the Chinese government announced that it would aim for complete decarbonization (carbon neutrality) by 2060 under the Paris Climate Framework. This announcement surprised the energy industry and experts from domestic and abroad. According to my interview, a group of NGO leaders and academics are responsible for introducing this ambitious policy. "I communicated the idea of carbon neutrality with the NEA officials back in 2016, but they thought it was too rushed and too ambitious," said Zou Ji, the former deputy director of China's National Center for Climate Change Strategy and International Cooperation (NCSC) and the current president of the Energy Foundation China – a US-based NGO focuses on promoting energy transition and climate change. "I then thought of starting with solid research, so we changed the strategy to funding research with our friends and partners at Tsinghua University." In 2017, Xie Zhenhua, the former minister of environ-

ment and Chinese special envoy on climate change, founded the Institute of Climate Change and Sustainable Development (ICCSD) at Tsinghua University. He invited a group of influential scholars in the field, such as He Jiankun, Li Zheng, and Zhang Xiliang, to join the ICCSD and conduct research on energy transition and decarbonization. In 2018, the Energy Foundation and ICCSD jointly funded a research project on the long-term low carbon development and transition path in China, which studied the timetable and feasibility of decarbonization. They brought together a group of well-connected climate scientists from Tsinghua University and the Chinese Academy of Social Science, as well as senior government officials from the NEA, NDRC, MEE, the Ministry of Transportation, and the Ministry of Commerce. Consequently, this research made a substantial impact on China's climate policy. "Eventually, minister Xie (Zhenhua) took the findings of our research to the top leaders and convinced Xi Jinping to make the carbon neutrality commitment," as Zou Ji puts it: "This (the Carbon Neutrality policy) is impossible without these group efforts and research evidence."

In general, my qualitative evidence helped understand how policy entrepreneurs utilize the state-social linkage to exert influence and promote decarbonization and energy transitions. This is, of course, not to say that Chinese energy and climate policies are made in a meritocratic manner, but rather to explain how deliberative voices are introduced into policy processes.

Conclusion

Authoritarian regimes are usually characterized by highly concentrated power, lack of accountability or institutionalized deliberation system, and over-reliance on coercion and elite cooptation. Therefore, policy processes in authoritarian regimes are deemed unidirectional, arbitrary, and non-transparent, serving the interests of authoritarian leaders and their allies (Boix and Svolik, 2013; De Mesquita et al., 2005; Svolik, 2012). Elements and dynamics outside of those state- and elite-centered ones are seen at best as trivial, if they ever existed. In environmental studies, this focus could be best illustrated by a popular concept of "authoritarian environmentalism": China's state-centric approach is marked by its effectiveness in producing

policy outputs, but the shortage of public participation and fragmented state bureaucratic system significantly limits the efficiency of these policies (Eaton and Kostka, 2014; Gilley, 2012). The actual process by which concrete policy decisions get made and implemented still largely remains a black box.

This chapter revisits China's policy processes in the energy arena, providing a micro-level foundation for the classic framework of the fragmented authoritarian governance system. In the absence of a functioning accountability system, the network structure that bureaucrats are embedded in contributes to their autonomy against capture. Quantitative and qualitative evidence suggests China's decarbonization pattern reflects that diversified stakeholders are involved in different policy process stages. Individual actors' influence is determined by their structural position within the policy network. It is the intricate interactions between these actors that drive the policy outcomes. This study also shows that policy processes in authoritarian regime settings share some common features with policymaking in democracies. It adds a more fluid and dynamic interest configuration process to the notion of political survival, the fragmentation or synergizing of interests.

Despite the rise in authoritarianism and xenophobia in China during the post-pandemic era, the diversified structure of state-society linkages remains resilient and resistant. When China terminated its Zero-Covid Policy towards the end of 2022, the channels of regular, face-to-face interactions were reopened among government officials, non-governmental organizations, research institutes, and business associations. Emerging industrial actors added to the reinvigoration of this intricate network. As the energy sector continued to evolve, nascent interest groups advocating for innovative energy technologies - such as energy storage, green hydrogen, offshore wind, and carbon capture, utilization, and storage (CCUS) — made their entrance into the policy-making arena. Although navigating the political landscape remains a challenge, the resurgence of networking activities underscores the resilience and adaptability inherent in the policy community, highlighting its capacity to foster and catalyze decarbonization amidst political turbulence.

Beyond specific policy and national context, this research further argues that heterogeneous

state-social linkages could contribute to state capacity for public goods provision. Previous literature on governance and public goods provision highlights the negative implications of heterogeneity. Using original social network data, this chapter provides quantitative evidence on the benefit of interest pluralism. I find that a diversified policy network reduces the level of bureaucratic capture and increases agent compliance and the state's capacity for policy delivery. This research also contributes to a growing literature on the benefit of diversity (Charnysh, 2019; Cruz et al., 2020; Wang, 2022).

These findings also carry practical policy implications for addressing global climate change. Pro-climate political leaders aiming to fulfill their international climate commitments should actively promote industrial diversification across various regions and encourage deliberation involving business and non-state actors at different stages of the policy process. Similarly, local governments should actively diversify their networks and establish connections with multiple sectors to balance the influence of localized fossil fuel interests in order to achieve their decarbonization goals. Internationally, as geopolitical competition and clashes between great powers intensify, engaging directly with the Chinese government on climate matters has become increasingly challenging. International climate actors should maintain and strengthen their connections with academic, social and business actors to influence policymaking in China. More broadly, for international climate policy entrepreneurs seeking to promote decarbonization in authoritarian countries, their focus should extend beyond accessing the government. Instead, they can influence policy by engaging with climate expert communities as an alternative approach.

Chapter 6
The Myth of Authoritarian Governance

"Power exists in every role, and in every relationship; it's a resource that flows between people who need one another. And because relationship partners, by definition, both need one another and have something to offer, power is almost never absolute. This means that all of us—regardless of who we are, how much we stand out, or how well we fit in, and despite how we feel—have power by virtue of the roles we play in others' lives."

— Deborah Gruenfeld in *Acting with Power*

Authoritarian regimes are usually characterized by highly concentrated power, lack of accountability or an institutionalized deliberation system, and an overreliance on coercion and elite cooptation (Acemoglu and Robinson, 2006; Boix et al., 2003; Przeworski et al., 2000; Svolik, 2012). Therefore, policymaking in authoritarian regimes is often deemed unidirectional, arbitrary, and non-transparent, serving the interests of authoritarian leaders and their allies (De Mesquita et al., 2005; Svolik, 2012). Consistent with mainstream literature, scholars who study China's energy transition focus on its state-centric characteristics. This pattern could be best illustrated by a popular concept of authoritarian environmentalism in environmental studies: China's state-centric approach is marked by its effectiveness in producing policy outputs, but the shortage of public participation and a fragmented state bureaucratic system significantly limits the efficiency of these policies (Gilley, 2012; Liu et al., 2017).

This state-centric pattern in the literature reflects the narrow focus on comparative politics and policy literature on China. Research that focuses on Western democracies, especially the United States, has long been paying attention to diverse aspects of policy formation and implementation, emphasizing the role of interest groups (Skocpol et al., 2000; Skocpol and Hertel-Fernandez, 2016; Stokes, 2020), the policy community (Baumgartner and Jones, 2002; Baumgartner and Leech, 1998; Jacques et al., 2008), and the dynamic interactions between formal and informal institutions (Huber and Arceneaux, 2007; Yackee and Yackee, 2006). The significance of network structures for policy research in democratic settings is widely recognized by social scientists (Ward et al., 2011). In political science, public policy, and sociology, there's extensive research into the formation and effects of these networks. In the field of climate change, a group of scholars also paid attention to network influence. They collected a total of 630 research articles on the climate network, and none of them came from China or other authoritarian countries [1].

This predominance of studies in democratic settings is primarily attributed to the fact that networking activities are more easily observable and potentially more impactful in democracies. Democracies, by their nature, tend to be more transparent and open to participation from a range of social actors, making the effects of networking more discernible. For instance, in the United States, highly organized interest group activists contributed to the polarization of environmental and climate issues at both the state and federal levels (Grumbach, 2020; Jacques et al., 2008; Stokes and Breetz, 2018). In the past 13 election cycles, the coal mining industry has been the largest source of campaign finance within the mining industry, with 88% of those going to Republican candidates [2]. In the early 2000s, the coal interest groups have significant influence in both the Congress and the White House. As a former staff member of the Democratic leadership recalled:

> "We [Senate democrats] tried to get [environmental/climate legislations] enacted during the Bush administration ... we were very close to a deal in 2001, so there would have been limits on the utility industry... but the Coal Industry and the

[1] See The COMPON project: http://h197.it.helsinki.fi/en.

[2] Data from the Center for Climate Strategies. http://www.climatestrategies.us/policy$_t racker/state$.

> Mining Association got to the Vice President's office, and they killed that bill. And they also got the President (Bush) to reverse his pledge during the campaign to control carbon dioxide from power plants [3]."

Coal interest groups found their natural allies in the conservative movement. Conservative think tanks, backed by the fossil fuel industry and the auto industry, play a major role in developing the rhetoric and talking points to support a position of climate denial (Boussalis and Coan, 2016; McCright and Dunlap, 2000). This all-powerful network was able to mobilize political and economic resources across the country to defeat all domestic climate policies under the Obama Administration, including Obama's centerpiece policy, the Clean Power Plan.

The Clean Power Plan (CPP) was a rule issued by the EPA under the Obama Administration in 2015 and served as an essential building block for the US international climate pledge. This policy aims to reduce carbon emissions from the electricity sector by 32% in 2030, relative to the 2005 level. The plan sets an achievable goal for each state and allows states to adopt the most cost-effective strategies to deliver those goals. The anti-CPP groups were not involved in the formal policymaking processes in the early policy formation stage. Instead, their strategy was to block the CPP by challenging the policy in the courts. Immediately after the CPP was announced, coal interest groups joined forces with other fossil fuel groups and the conservative movement to challenge the policy using the court system. A total of 24 states with Republican governors, including Alabama, New Jersey, Texas, West Virginia, Wisconsin, Wyoming, etc., sued the EPA, arguing that the Federal government does not have the authority to regulate a state's carbon emissions under the Clean Air Act. Note that only less than half of those 24 states have coal-dependent counties. The conservative policy community is the main force behind these lawsuits. They contend that regulations and unfair subsidies for renewables make coal expensive, causing the decline of coal. In early 2016, the U.S. Supreme Court placed a temporary hold on the CPP. Under the Trump administration, the EPA replaced the CPP with a new Affordable Clean Energy (ACE) rule, which imposed no meaningful mitigation requirement for the power sector.

[3] Interview 12202019

In comparison, research on China's policymaking has a relatively narrow focus. Most existing studies fall into one of three strands. The first strand highlights the negative policy implications of fragmented authoritarianism in China's political system by studying the vertical and horizontal bureaucratic structure (Cai and Aoyama, 2018; Lieberthal and Oksenberg, 1988; Mertha, 2009). The second stands analyze authoritarian responsiveness and consultative authoritarianism. Despite the authoritarian nature of the regime, the party-state still seeks limited public participation channels to collect information and policy feedback, in order to identify potential problems and solutions (Anderson et al., 2019; Chen and Lees, 2016; Chen and Xu, 2017; Distelhorst, 2017; Distelhorst and Hou, 2017; Gueorguiev and Malesky, 2019; Meng et al., 2017; Miller, 2015; Pan and Chen, 2018). The third strand addresses the concept of political survival, in which the longevity of authoritarian regimes depends on the rulers' successfully co-opting elites. From this perspective, policies are understood as a tool for cooptation and compromise, and policy outcomes are reflections of the struggles among, and the power structure of, political factions and interest groups (Jiang, 2018; Jiang and Zeng, 2020; Steinberg and Shih, 2012; Truex, 2020; Wang, 2016, 2018)

These insightful studies have contributed tremendously to the scholarly understanding of many aspects of authoritarian policy formation in China, but they share two critical inadequacies. First, despite their essential theoretical contributions, some of this literature is built on an inaccurate picture of reality. In fact, China's policymaking involves substantive persuasion-based influence, by which I mean ideas rather than interests, without democratic empowerment (Li, 2017). The deliberative influence has an independent effect on policy outcomes in the absence of structural changes in political power. Second, the literature has identified a number of potentially influential factors for final policy outcomes, but the actual process by which concrete policy decisions get made and implemented still largely remains a black box. I argue that these two problems result from the reification of the category of "authoritarianism." The aforementioned conventional wisdom includes multiple theoretical expectations about what an authoritarian regime should look like: authoritarian policy is a measure of interest distribution among elites in exchange for political support; Authoritarian policymaking process is top-down or hierarchical because these regimes lack checks on power and space for bottom-up approach;

Authoritarian policy considers public demand due to the threat of rebellion rather than the power of persuasion. These expectations become presumptions that guide scholars in a specific direction as they try to explain phenomena in a particularly authoritarian country.

Specifically, because authoritarianism is, theoretically, characterized by power concentration and exclusive decision-making, many scholars are naturally drawn to the central state and the ruling coalition in the study of almost any political matter in China. Elements and dynamics outside of those state- and elite-centered ones are seen at best as trivial, if they ever exist. The strict but largely arbitrary dichotomy between "autocracies" and "democracies" further guides scholars away from factors identified as important determinants of policy formation in democratic settings, such as the policymaking process legislatures, policy networks, and policy communities in the society. Only very recently have several researchers begun to notice these factors. Their studies have contributed critically to bridging gaps in the literature (Duckett, 2019; Lu and Nemet, 2020; Shen, 2017; Teets, 2018; Williamson and Magaloni, 2020; Zheng et al., 2010), showing the great value in studying these niches that are common to policymaking in different institutional contexts.

Most existing works, however, fail to present concrete evidence linking quantifiable network analysis with policy outcomes. To some extent, this can be attributed to the opaque nature of policy formulation in authoritarian China. The internal departmental political rivalries, lobbying efforts by interest groups, and the decision-making process of the elites are typically confined to a select group of political insiders. Questions like: Who are the participants in the policy-making process? To what extent does their participation bear an impact on the policy outcomes? And most crucially, why do authoritarian regimes tolerate networking activities and the influence of interest groups in the policy process? are all relevant and yet largely unanswered.

My dissertation bridges this gap by providing a more realistic understanding of policymaking in authoritarian regimes. It aims to unveil the intricacies of political dynamics in the realm of climate and energy, opening up the 'black box' authoritarian policymaking process. I specifically focus on the power dynamics between policy actors, major actor interactions, and

the consequence of the specific network structure, thus shedding light on the complexities of authoritarian governance.

My fieldwork experience provides some insights into policy formation in energy and climate policy. Based on my field experience, a group of climate and energy scientists has a strong influence on policymaking because they are embedded in the network of decisionmakers. For instance, two scientists, Professor He Jiankun and Professor Luo Yong of Tsinghua University, played a critical role in advising Politburo to acknowledge the significance of climate change, further advancing its priority on China's policy agenda since 2008.

This is not to say that interest politics do not matter to policymaking, or that Chines policies are made in a meritocratic manner, but rather explain how social voices are introduced into the policy process. In fact, interest groups could also utilize their network to exert influence on policymaking and policy implementation. For instance, experts from the State Grid routinely provide consultant services to the government regulator and participate in the policymaking process. The National Energy Administration and local government rely heavily on the grid experts to assist industry policy and electricity provision, opening up opportunities for the State Grid to influence government actions. The State Grid has utilized its monopoly over technology expertise for policy retrenchment, push-back electricity market reforms, and restructuring. This significant economic power undoubtedly wields considerable influence in shaping national policies. However, the mechanism through which such macro-structural elements transform into political power and policies can be analyzed through micro-level policy networks.

Building on the recent literature and my fieldwork experience, I find that attributing policy outcomes to a fragmented bureaucratic system and political survival is an oversimplification of the complex policymaking process. There are diverse stakeholders involved in different stages of the policy making process, and their influence is determined by individual structural positions within the policy network. I argue that China's seemingly self-contradictory decarbonization pattern reflects these intricate dynamics in different stages of the policymaking process. My theory consists of three hypotheses: 1) deliberative influence is prevalent in

policy enactment. The structure of the policy network provides policy entrepreneurs a platform through which individuals connect and attempt to influence decision-makers in a subtle and indirect way; 2) in the policy implementation stage, interest groups work through networks to push for policy retrenchment; 3) the specific policy outcome can be attributed to the structure of networks in the period of policy enactment and implementation.

This theory was tested by examining three observable phenomena. First, if the network influence exists in the policymaking process, we can observe diversified network-building efforts during policy drafting on a particular issue. Such efforts intensify before the enactment of policy and decrease after implementation. Second, policy actors' affiliation to the corresponding issue area provides the key leverage for deliberative influence. Third, we should also observe policy changes, in this case, renewable development, as the policy network around government decisionmakers diversifies.

My study illustrates that the policymaking process in an authoritarian setting shares some common features with policymaking in democracies. The Chinese case may shed valuable light and provide comparative insights into our understanding of the decision-making process in non-democratic countries. It is a more fluid and dynamic interest configuration beyond the simplistic notion of political survival, the fragmentation or synergizing of interests. I argue that the diverse preferences and common grounds among stakeholders coexist in almost every policy arena, and it is the intricate interactions between these two sets of dynamics in different stages of the policymaking process that drive the policy outcomes. For climate change specifically, the authoritarian government's exposure to the diverse network, which includes substantial social and international actors, is a crucial driver for China's decarbonization.

The theory of network diversity does not only apply to climate policy. I argue that the diversity of policy networks in which decision makers are embedded contributes to compliance and effective policy delivery in policy areas with *information asymmetry* and *sufficient interest competition* because heterogeneous connections provide them with more information and alternatives for securing political support. Considering the complexity of society, policymakers can no longer make arbitrary decisions without consequences. In reality, social actors are actively

involved in many policy areas. Policymakers, therefore, engage in networks of social relations involving various stakeholders and social actors. For instance, technology innovation policy is a complex arena that involves multiple stakeholders competing for limited government support. The complexity and fast-evolving nature of technology pose an immense challenge to government agents, who may lack specific expertise in scientific and technological development. This knowledge gap necessitates a reliance on external experts from industry and research institutions, who are equipped with the most up-to-date information and understanding of the field. Government agents, in turn, engage with a broad spectrum of stakeholders – from researchers and industry leaders to non-governmental organizations and international partners – in an effort to collect insights, validate ideas, build consensus, develop, and evaluate policy. The network between the government and external experts is critical in the formulation of technology innovation policies, where sound decision-making depends on a comprehensive understanding of the technological landscape, as well as the political and social factors that might influence its adoption and implementation. A diverse network can ensure different voices and opinions are considered in the policymaking process and create a competitive environment that facilitates government autonomy against specific interest groups. Similar network effects can also be found in finance, health care, education, social security, and complex policy arenas. This phenomenon reflects the complexity of governance in the contemporary society.

Such diversity, however, has been facing several challenges since the COVID-19 pandemic. Since 2018, the Chinese government has become increasingly authoritarian and nationalist, shutting the door to international policy actors. During the pandemic, conferences were shifted online and lost their merits as a networking platform. The central government prioritized immediate health threats, economic growth, and energy security, instead of addressing climate change, resulting in a significant coal pushback. In 2022, China announced 14.5 billion USD in targeted subsidies in the form of loans for the coal mining industry, focusing on coal production, storage, and transportation, and 29 billion USD for the coal-fired electricity industry. In the wake of the Russia Invasion, geo-political and energy security concerns also re-emerged as a major talking point. Since 2022, the head of the NEA has repeatedly stated the importance of coal and calling it the “cornerstone of energy security.” Xi Jinping himself also publicly warned

against fast decarbonization, reinforced the direction that coal would be the "cornerstone" of national energy security and economic development, and instructed that coal's role "would be hard to change in the short-term".

As the largest coal user, China's policy retrenchment is particularly consequential. As shown in the previous section, since 2016 China's coal production has been rising and reached an all-time high by the end of 2022. In addition, the government temporarily lifted import tariffs on all types of coal in order to secure coal supply. Such a move could benefit imports from Russia (the tariff was at 6% for thermal coal), since the tariff is already 0 for Indonesian coal and there is a ban on Australian coal. In terms of coal power plant construction, local governments have been using coal-powered construction projects as easy boosts for the local economy. In 2022, an additional 91 coal-powered projects with 106 GW combined total capacity were approved, four times higher than the retired capacity of the rest of the world combined.

In addition, the return of geopolitics is likely to haunt the global energy transition for decades to come. In the past three decades, Europe and North America made significant progress in coal phase-out because of the sufficient and cheap supply of natural gas and renewable technologies. The international environment that supported such a transition, however, was weakened by the ongoing great power competition. As geopolitical tensions with China intensify, concerns about energy security will limit the energy options for the US and its allies. Politicians have also raised alarm about China's dominance in the solar and electric car industries. If affordable and sufficient alternative production is not available, developed countries are more likely to stick with fossil fuels like coal longer than they had initially expected.

Furthermore, political tensions between China and the United States discourage both official and non-official engagements. It's widely recognized that the bilateral relationship between the two nations is at its most strained since diplomatic relations were established in 1979. Climate cooperation, previously considered a bright spot in bilateral engagements, now finds itself overshadowed by the prevailing tension in the relationship. This indicates that great power competition has suppressed international cooperation and coordination for net-zero decarbonization. Considering mutual trust and collaboration among the world's major emitters

was what made the Paris Climate Agreement possible, the future of climate also hinges on continued efforts that could further accelerate countries' mitigation action and ambitions (the ratchet mechanism). As geopolitical competition and the clash between great powers intensify, such intensive collaboration among large economies would be difficult to replicate. Even though the Paris climate framework is still intact for now, whether the international climate governance system would still be effective under the contentious global environment remains a question. Once again, the fact of mankind is at stake.

Despite the complexities of the post-pandemic domestic and international political environment, the established network of policy actors remains intact and resilient. Throughout the pandemic, several U.S. policy actors with close ties to the Biden Administration (also with John Kerry), including Kelly Gallagher, Todd Stern, Henry Lee, and John Holdren, have managed to maintain consistent dialogues with their Chinese counterparts, such as Xie Zhenhua, He Jiankun, Wang Yi, and Zou Ji. Officials from European delegations in China were also invited to many online conferences, hosted by influential domestic climate policymakers. Significant initiatives, like the influential Harvard-Tsinghua Climate Policy Workshop, continue to foster communication and collaboration on critical topics. For instance, thanks to the solid foundation of unofficial communication established through these networks, the U.S. and China delegations were able to reach an agreement and issue the U.S.-China Joint Glasgow Declaration at COP 26. Following this, policy actors on both sides mobilized researchers to conduct in-depth studies on methane emissions, a primary focus area for achieving deep decarbonization. This is a testament to the robust nature of these relationships, which have not only withstood but also adapted to the circumstances.

After China ended its Zero-Covid Policy in late 2022, the Chinese government, NGOs, research institutes, and business associations were able to resume regular in-person interactions. As the energy industry continued to develop, the post-pandemic period also coincided with the diversification of the energy sector, giving rise to a new wave of interest groups. Representatives for emerging energy technologies such as energy storage, green hydrogen, offshore wind, and CCUS began to assert their presence more frequently in the policy arena. Government

officials returned to their customary routine of participation in various conferences, further stimulating the dialogue between the government, the industry, and the social sector. This renewed vibrancy also saw international actors re-establishing their in-person presence in China, reengaging the international cooperation that is vital to global policy progression. Although the political environment remains challenging, the re-emergence of these networking activities highlights the resilience and adaptability of the policy community, underlining its capacity to foster collaboration even in challenging circumstances.

Politics is essentially a form of relationship. Although policymaking in an authoritarian context often appears as a black box to observers, examining the intricate network within this system can reveal the complex machinations of policy decisions, alliances, and power dynamics at play within such a system.

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